

Lilu's House

Language Skills through Experiments



SCIENCE  ON STAGE
GERMANY

THE EUROPEAN NETWORK FOR SCIENCE TEACHERS

For Primary School Teachers

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Science on Stage Deutschland e.V.
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Coordinators

- ▶ Petra Breuer-Küppers, Ministry of Education
North Rhine-Westphalia, BackStageTeam
Science on Stage Deutschland e.V.
- ▶ Dr Jenny Schlüpmann, Freie Universität Berlin,
BackStageTeam Science on Stage Deutschland e.V.
- ▶ Mario Spies, Grundschule Landkern,
Board Science on Stage Deutschland e.V.

Project management and editing

- ▶ Lisa Ehrlich, Project manager
Science on Stage Deutschland e.V.
- ▶ Karoline Kirschner, Project manager
Science on Stage Deutschland e.V.
- ▶ Stefanie Schlunk, Executive manager
Science on Stage Deutschland e.V.

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Revision and translation

Simon Banwell, english-house

Credits

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www.science-on-stage.de
info@science-on-stage.de

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through Experiments



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Foreword

Dear teachers,

Through the use of creative teaching and learning methodologies you encourage children's imagination, curiosity and desire to explore and learn about the world around them. This allows children the time and opportunity to engage with many different everyday scientific concepts. Science on Stage Germany also aims to inspire and excite children about science from a very young age. The Science on Stage team is collaborating with a wide range of teachers, from early childhood, through to elementary and right up to second level education, to facilitate the exchange of ideas and share expertise. One aim is to produce high quality evidence based teaching and learning resources that are transferrable across all curricula. For the development of this publication primary school teachers from all over Europe have used inspiring examples to introduce you to new teaching perspectives and show how children's interest in science can be increased and intensified using strategies that promote literacy skills in the classroom.

The publication 'Lilu's House: Language Skills through Experiments' provides teachers with suggestions and tools for their own lessons and combines and connects the promotion of language skills with the use of scientific experiments. The story includes texts and assignments with varying levels of complexity to ensure inclusion and to cater for a mixed ability classroom and children with differing levels of literacy skills and literacy needs. The main focus of the teaching resource is on promoting language skills through oral language, reading and writing during science lessons. These activities also facilitate the exploration of scientific concepts in the story about Lilu's house. In this way, the children develop scientific process skills and subject matter knowledge. Therefore, primary school teachers delivering these lessons in their classroom do not need a strong scientific background in order to do so successfully.

The teaching units were developed and tested by ten committed primary school teachers from seven European countries. This has resulted in a wide range of creative and innovative pedagogical approaches in every chapter. The connecting element

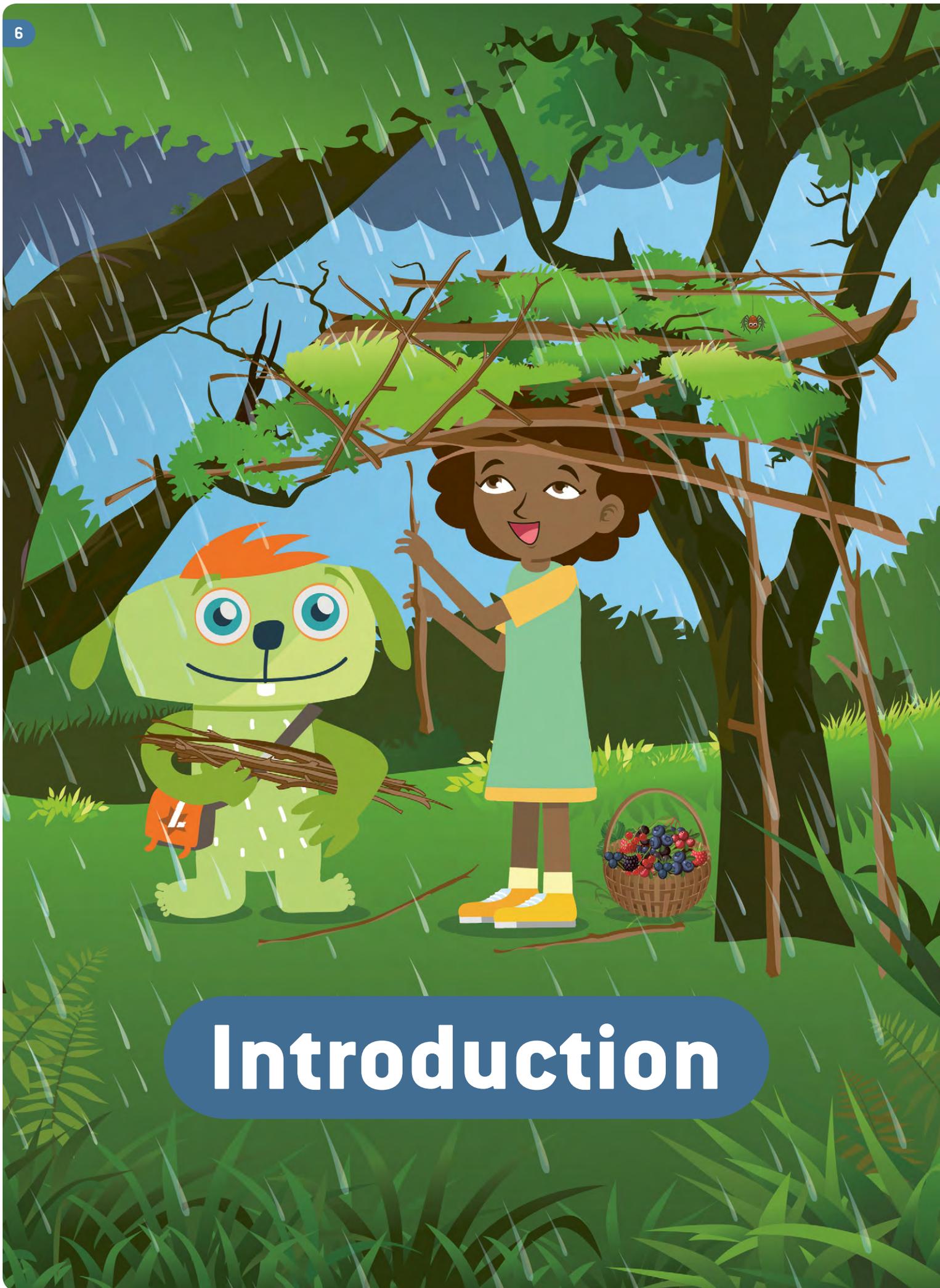


throughout is the fantasy creature Lilu and his friend, a girl called Alina. The home, which is a direct link to something children know from their own world of experience, serves as the starting point for their adventures. The two friends go on a discovery tour of Lilu's house and find all kinds of 'inexplicable' things there, e.g. misted-up mirrors in the bathroom, bouncing beans in the living room, and the secrets of yeast in the kitchen.

The bathroom, kitchen and living room encourage not only exploratory learning, but also the practice of linguistic elements: words for objects or actions, sentence patterns, reading comprehension, or listening. The library contains information about the teaching methods and activities used within the units. In addition, links are provided which lead the reader to further in-depth material, texts in easy language and worksheets that can be downloaded from the Science on Stage homepage free of charge.

We hope you find the activities and ideas in this teaching resource useful and helpful when looking at integrating language skills development into your science lessons. If you have any questions, please feel free to email the Science on Stage Germany office (info@science-on-stage.de).

Your Science on Stage team



Introduction

Lilu and Alina are in the forest collecting berries. After a while, dark clouds gather and it starts to rain. Quickly, they look for a place to hide. Using branches and moss they build a little hut. Unfortunately, the roof is not waterproof, and soon Lilu and Alina are soaked to the skin. Once the rain has stopped, they make their way back home. At the edge of the forest, Lilu says to Alina: 'Let's meet again tomorrow to improve our small shelter.'

Lilu follows the path to his house and jumps happily from puddle to puddle. At home, he takes off his wet clothes and puts them to dry on the clothes horse in the bathroom. Lilu looks into the mirror and sees a little spider in his hair: 'Oh, a stowaway, it probably fell on my head while we were in the hut.' He gently removes the little spider from his hair and releases it onto the wall: 'Hello, little spider, where do you come from?' The spider quickly runs towards the mirror.

The next day, Alina comes to Lilu's house. They look for the little spider and find it in a corner of the bathroom ceiling. Alina cautiously reaches out her finger. The spider crawls onto her hand, then over her arm, up to her shoulder. Alina takes the spider on her left hand and puts it down on the windowsill. The spider has seen a dead fly in the corner of the windowsill and runs towards it. Lilu realises what the spider has in mind and shouts: 'No, no, stop! Please, don't eat the fly, I want to look at it with a magnifying glass first. I'm especially interested to see its eyes and wings. Hm, I wonder what its legs look like. And do you think it has ears?'

The little spider stops: 'Are you a scientist? I would so much like to be one too.' Lilu answers: 'I'll show you how to be a scientist, and once we have finished observing the fly, you may eat it.' No sooner said than done. In turns, they look through the magnifying glass and are impressed by the fly's compound eyes and its delicate, almost transparent wings.

But the little spider ponders: 'I think I'll forget about being a scientist. I don't want to spend the rest of my life investigating insects. I'd rather eat them immediately.'

Lilu chuckles: 'Science is so broad and involves much more than just looking at insects. You can investigate anything you're curious about. Just ask a question, find a problem – and look for an answer.' The spider becomes thoughtful: 'I have to think about it. I'll go back to my hiding place behind the mirror.' Well hidden behind the mirror, the spider discretely spies on Lilu and Alina.

Lilu and Alina do not need convincing: they are enthusiastic about science and always want to try out new experiments. Lilu shows Alina around his house. 'Where should we start today? In the bathroom? There's a big mirror, a shower, towels, toothbrushes and toothpaste. Or in the kitchen? There's a table with a big bowl of fruit, chairs, an oven, cupboards and lots of kitchen utensils. Or maybe in the living room? There's a big, comfortable sofa and many plants. My father likes to grow plants from seeds.' 'That sounds fantastic! Let's begin in the bathroom!' Alina says enthusiastically.





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!

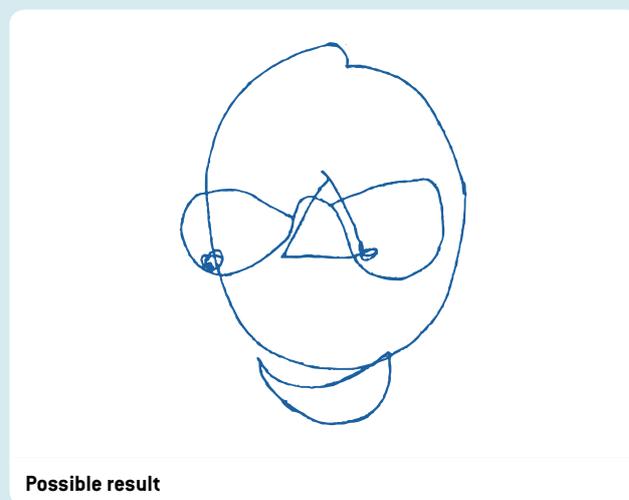
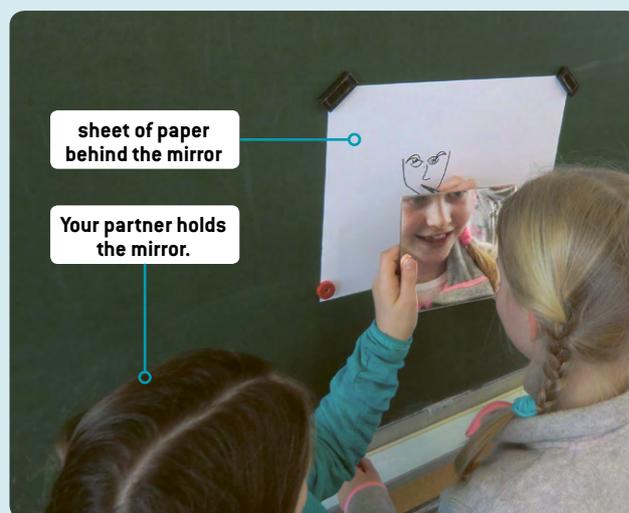
! Stop and jot down!

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!



! 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

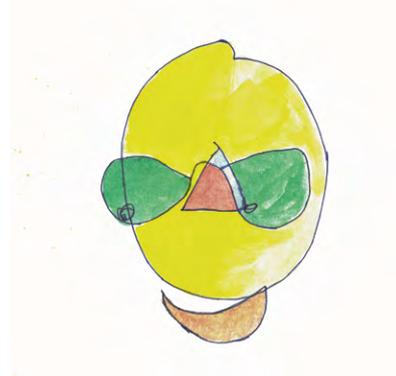
Everything can be accompanied orally while doing the task:

▶ 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.^[4]

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

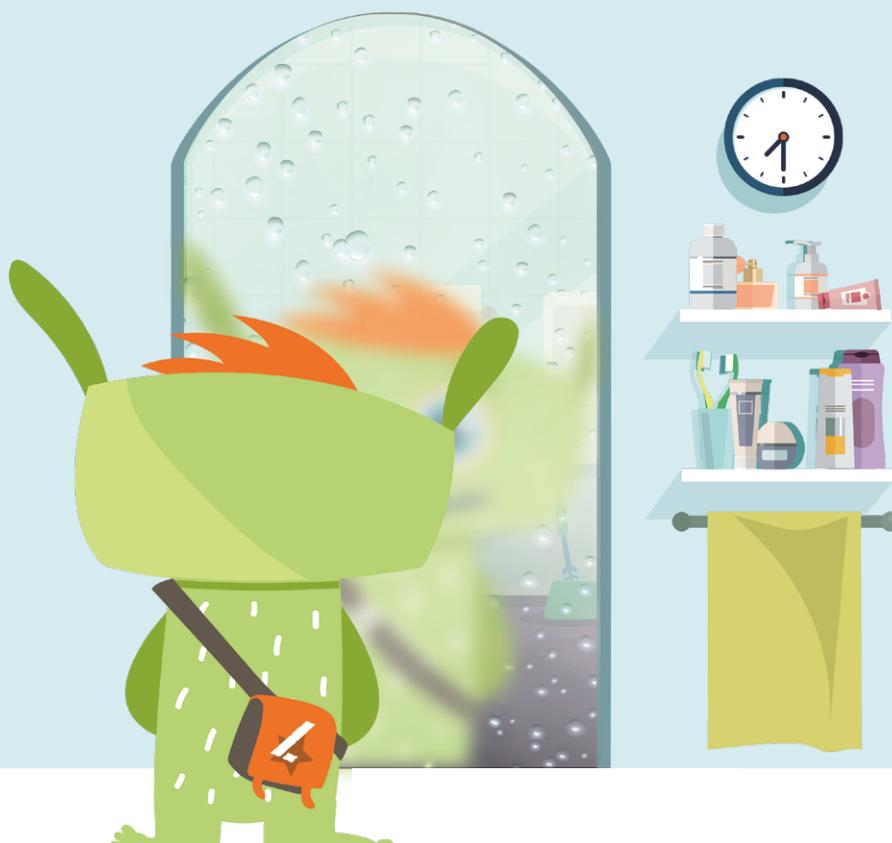
The word cards can be used to label materials and devices.^[1]

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 wall-paper, 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!

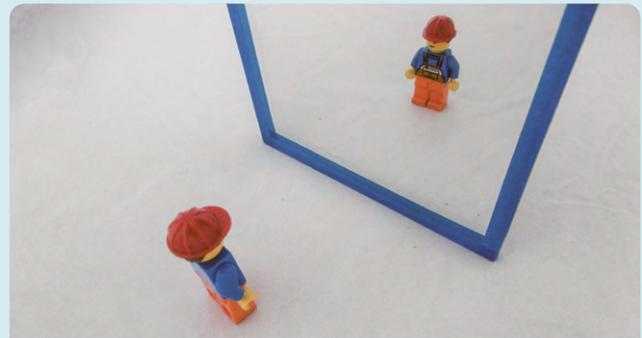
What happens with Alina's and Lilu's mirror image? Make assumptions.

- ▶ 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:

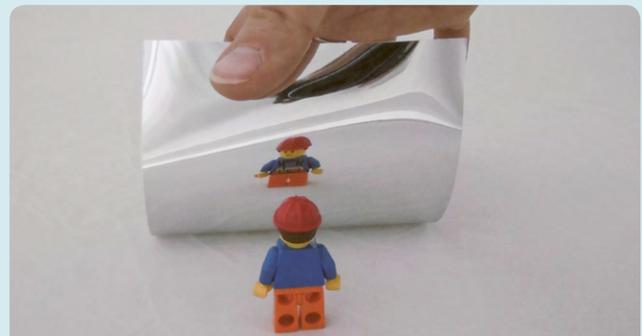
- ▶ Keep the flexible mirror straight and look at it so you can see the little toy the same way as in a plane mirror.



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

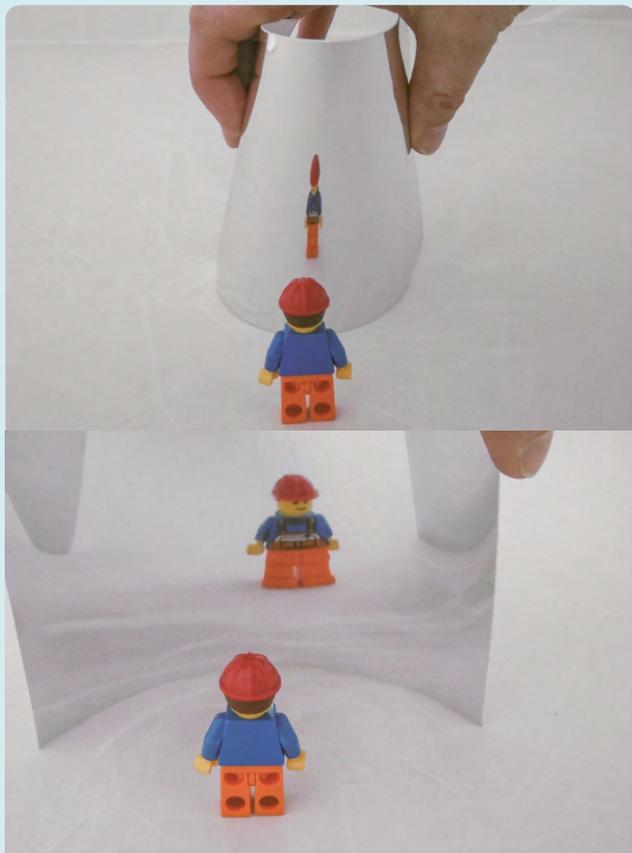
- ▶ Bend the middle of the mirror in the other direction and watch the toy's reflection change.



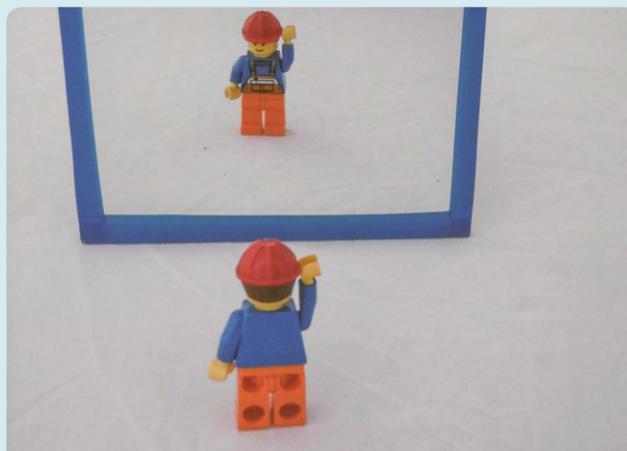
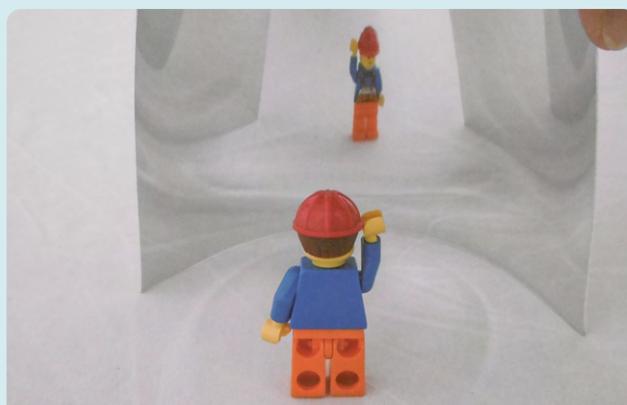
Mirror bent vertically: Bottom and top are flipped

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 Lilo and Alina to dinner. Before dinner, the two friends help to set the table. Lilo is looking at the ladle. Another Lilo 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 Lilo'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!

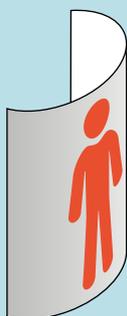
Name the different reflective things and describe how you see yourself in them.

Learned vocabulary overview

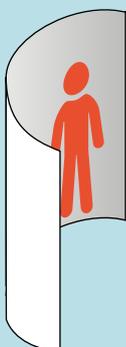
- ▶ comparative adjectives, nouns and verbs, e.g. big, bigger, bottom, fix, inside, ladle, large, larger, left, outside, overturned, right, short, shorter, slim, slimmer, small, smaller, spoon, tall, taller, top, turn, upside down
- ▶ names of different reflective things at home, e.g. handle, kettle,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

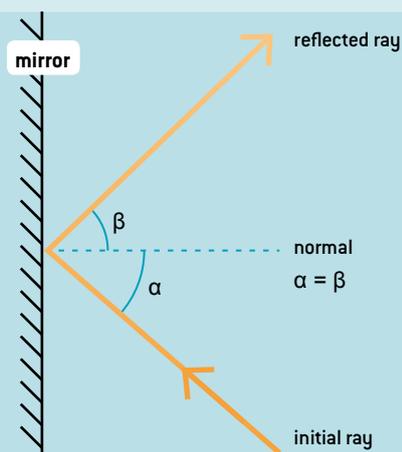


convex mirror

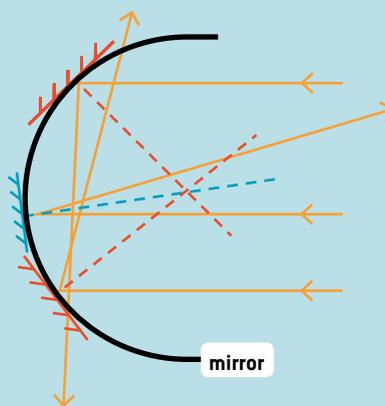


concave mirror

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 vocab-

ulary 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 Alina 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, Lili? 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,' Lili 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}



Kitchen

Curiosities

Conceptual introduction

The teaching unit 'Kitchen Curiosities' plays in two different settings: the school yard (→ page 38) and the kitchen itself (→ page 43). If you want to know what can be found in a kitchen you can head for the vocabulary corner.^[1]



In the story, the children are introduced to the origin of the Hindu-Arabic numeral system. The Hindu-Arabic numerals are compared to Roman and ancient Egyptian numerals.

The children also learn about different kinds of bread and baked goods:

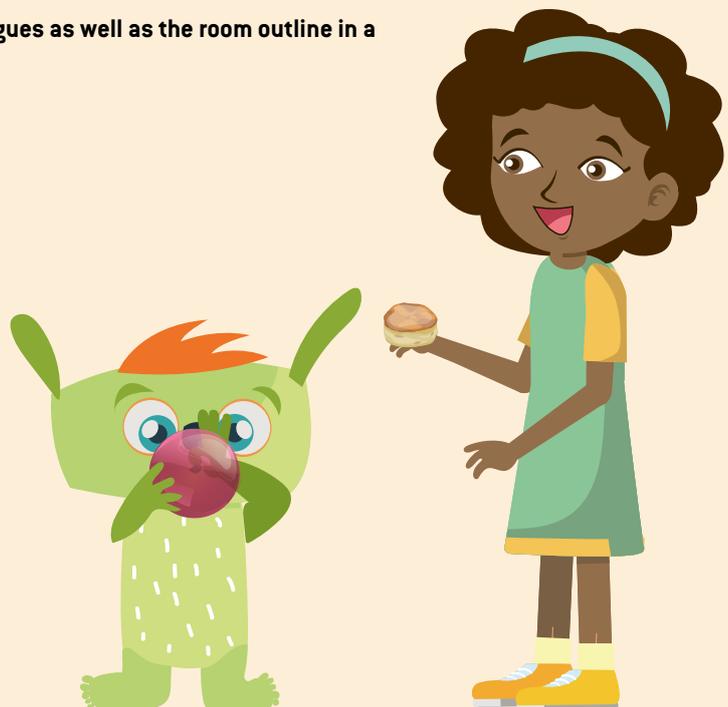
- ▶ chapatis from India, Afghanistan and East Africa
- ▶ naan taftoon from Iran, Pakistan and Northern India
- ▶ pita bread from Syria, Lebanon and Greece
- ▶ focaccia from Italy
- ▶ scones from Great Britain

Except for the chapati dough, all these doughs contain yeast or baking powder: dry yeast in naan taftoon and pita bread, fresh yeast in focaccia and baking powder in scones.

The children are asked to decipher bread recipes in Arabic, Hindi and Persian. This puts children from countries with Latin writing in a situation in which they are confronted with a text they cannot read – a common situation for children who are not yet familiar with Latin writing.

The kitchen is a perfect place to experiment with yeast and dough. In the first experiment (→ page 48), the children investigate the effects of dry yeast and learn how to handle experiments with several independent parameters. The second experiment (→ page 50) is about how the different doughs float or sink. In the third experiment (→ page 52), cabbage juice, lemon juice and baking soda are used to change the colour of the dough.

- ▶ **You can find the plain texts and dialogues as well as the room outline in a printer-friendly version online.**^[1]



Lilu and Alina at school

SUMMARY

The children discover various kinds of breads eaten in different countries of the world. They learn about the origin of our numerals and make simple calculations with Roman and ancient Egyptian hieroglyphic numerals. The children examine different kinds of grains and identify the germ and the bran. Also, they can talk about the availability of drinking water.

LEVEL

●●● difficult

DURATION

3 × 45–60 minutes

VOCABULARY

names of flatbreads, bread ingredients, countries

MATERIAL

- ▶ a globe or a world map
- ▶ worksheet A – Roman and ancient Egyptian hieroglyphic numerals^[1]
- ▶ different kinds of grains (e.g. wheat, oat, rye)

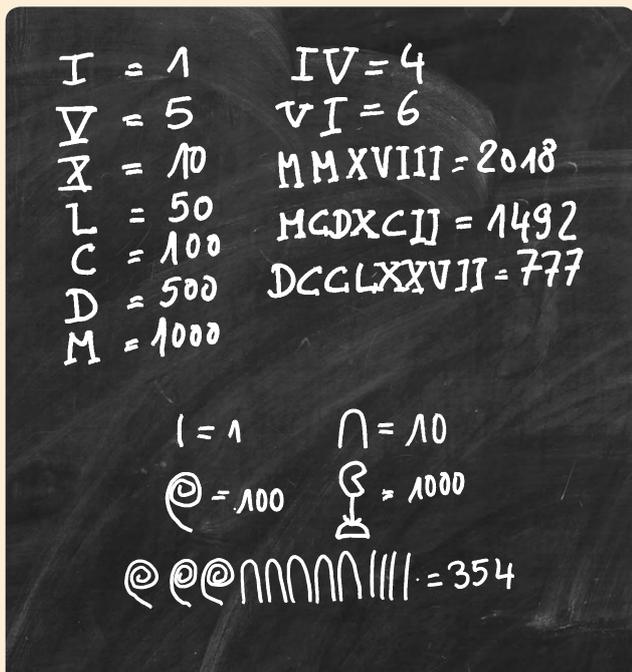
The math lesson is over and the children of class 4 are rushing out into the schoolyard holding their break time snacks. Alina, Malaika, Tom, Jamuna, Asal and Paolo meet at their favourite place: the two benches under the plane tree. The six children are very close friends. The teachers call them 'United Nations': Alina is from London (United Kingdom), Malaika from Aleppo (Syria), Tom from Berlin (Germany), Jamuna from Jaipur (India), Asal from Isfahan (Iran) and Paolo from Genoa (Italy). Malaika came to London just a few months ago. She and her family had to flee from the Syrian civil war. Her English is already very good.

! Stop and spot!

Find the towns and countries of origin of the children's families on a globe or a world map.

Alina, Malaika, Tom, Jamuna, Asal and Paolo are talking excitedly about their math lesson: Today they have learnt about the Hindu-Arabic numerals. The ten numbers they have to juggle with each day – 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9 – originally came from India. They have compared these numerals to the Roman numerals and to the ancient Egyptian hieroglyphic numerals.





Roman and ancient Egyptian hieroglyphic numerals

Tom: Jamuna, it's great that your ancestors invented our numbers – just imagine if we had to deal with Roman numerals or the ancient Egyptian numerals.

Jamuna: Oh yes, I totally agree – Hindu-Arabic numerals are so much easier to deal with.

Background information: The Hindu-Arabic numeral system

Indian mathematicians invented our decimal number system, including the digit zero

0, 1, 2, 3, 4, 5, 6, 7, 8 and 9

around the year 500 – approximately 1,500 years ago. Later, in the 7th and 8th century, the Indian numeral system spread to several Arabic countries before it moved on to Europe in the 9th century, where it gradually replaced the Roman numerals.

Stop and sum up!

For the teacher: Introduce Roman numerals and how they are 'assembled' as well as ancient Egyptian hieroglyphic numerals.

Asal: I like the ancient Egyptian numerals. Look at, for example, 777. Such an easy number. With hieroglyphs, it's quite long to write, but at least you don't have to think much. Let's try to add up 777 and 333.

Paolo: That sounds great – I like the Roman numerals and I'll try to work it out too.

Stop and practice!

Solve the exercises in worksheet A – Roman and ancient Egyptian hieroglyphic numerals.^[1] You can also invent your own calculations and solve them.

Lilu suddenly appears and jumps on the backrest of one of the benches.

Lilu: I was hiding in the tree and listening in on your conversation. Have you ever thought what it would be like if we had no



numbers at all? *Lilu sings:* I have a head, and a few arms, and a lot of fingers, and the same amount of toes. I have more ears than noses. *Lilu and the children are laughing their heads off.*

The children open their lunch boxes and start to eat.

Alina to Asal: You always have these pancakes in your lunch box – they look so yummy. They look so much tastier than my sloppy toast sandwich.

Asal to Alina: It's not a pancake, it's a flatbread. We call it naan taftoon or taftoon bread.

Paolo: Funny name! My bread is called focaccia – it's not as flat as yours, and there are holes in the dough, look. It has lots of olive oil in and on it, and rosemary. Focaccia is made with fresh yeast.

Lilu steals a piece of Paolo's focaccia and quickly stuffs it into his mouth.

Lilu: Hmmm, delicious ... olive oil and rosemary.

Asal: My taftoon bread is also made with yeast – with dry yeast. It looks like light brown grains, a little bit like coarse sand. It comes in little packets.

Malaika: Pita bread is also made with yeast, yeast from little packets. When my father makes pita bread, I help him.

Recipe for focaccia

For the dough:

- ▶ fresh yeast (40 g)
- ▶ 1 tsp. of sugar
- ▶ 200 ml of lukewarm water
- ▶ 400 g of wheat flour
- ▶ 100 g of semolina
- ▶ 100 ml of olive oil

For the top of the bread:

- ▶ 1 tbsp. of coarse sea salt
- ▶ 2 tbsp. of fresh rosemary

Mix all ingredients to a dough and let rise in a warm place for 30–40 minutes. Place the dough on a baking tray and flatten it out. Sprinkle coarse sea salt and fresh rosemary over dough. Bake for 25–30 minutes in a preheated oven (200 °C).

Preparation time (without resting and baking): 20–30 min

ⓘ Stop and jot down!

Look up the meaning of the words that are new to you. Write them down in your exercise book together with an explanation. You can also add a drawing or bring the item (e.g. rosemary, yeast) into class.



For the teacher: The children could work in groups, each group looking up two or three words and then explaining these words to their classmates.

Alina: Hey Jamuna, your bread looks like a pancake too. Only my toast and Tom's bread look different. Tom, is that the great wholewheat bread that your father bakes?

Tom: Yes, it is. I like it, and my father keeps on saying how healthy it is.

📌 Stop and jot down!

Make a list of the flatbreads introduced in this story. Look up on the Internet which countries they are eaten in and how they are eaten. If you know of more types of bread, you could add them to the list. You can also make a presentation for your classmates.

Lilu interrupts him.

Lilu talking like a professor: Wholewheat is much healthier. Whole grains still have their shell, also called bran, and the germ. Bran and germ contain fibres, vitamins, minerals and oil. I eat a lot of wholewheat bread and look how healthy I am.

📌 Stop and draw!

Look at a plain wheat grain and a wholewheat grain with a magnifying glass. Identify the bran and the germ. Make a drawing with the parts labelled in your exercise book.

📌 Stop and sort!

The children and/or the teacher bring several different kinds of cereal grains into class: wheat, oat, rye, barley, spelt, maize, rice, millet, etc. Other grains look like cereal grains, but they are not. There are pseudo-cereal grains like amaranth, quinoa, chia and buckwheat, or seeds like sunflower, flax, hemp and poppy seeds, or pulses like beans, chickpeas, lentils, peanuts, etc.

Task: Sort out the grains, seeds and pulses you and your teacher have brought into class. Look for information on the Internet.

📌 For more information on beans, please go to the living room (→ page 56).

Lilu does a cartwheel on the backrest, jumps onto the backrest of the second bench, jumps into the tree and hangs upside down from a branch of the tree.

Alina: Oh Lilu, we know that you are the greatest, the most beautiful, the most intelligent creature on earth.

Tom: I would so much like to try all your breads. They look really interesting. Maybe we should meet at the weekend and have a big bread party?

Lilu: Great idea! Why don't you all come to my house? A bread party, a bread party, I'm organising a bread party!

Alina: But aren't these breads too difficult to make?

Jamuna: My chapatis are very, very simple to make, I've made them several times. You just need flour and water. If you want, you can add a little bit of salt and a spoonful of oil. You take a little ball of dough, roll it out very thinly, and put it in a flat iron pan, which we usually call tava. Tom, your idea with the bread party is fantastic. Lilu, I will bring our tava. And flour. I won't bring water though – I hope you have some at home.

Lilu: Haha, of course, I've got running water at home, I even have cold and warm water! I also have a bathroom with a shower and a big mirror and a living room with a really comfy sofa.

📌 Stop and discuss!

We take it for granted that water comes out of the tap whenever we want. That is not the case though in many parts of the world. In many countries, (clean) drinking water is scarce.

Task: What would you like to know about drinking water? Find answers in books and/or on the Internet.

For the teacher: Questions could be: How is drinking water supplied? How many litres of drinking water do we use each day and for what purposes? How big is the share of drinking water compared with all the water on earth? (Answer: If all the earth's water – oceans, lakes, glaciers, etc. – is a bucket filled with 10 l of water, the amount of drinking water is only 4 ml.)^[2] For more information on water, please go to the bathroom (→ page 33).

Asal: Jamuna, is it OK, if I use your tava to bake my taftoon bread? In Isfahan, a town in Iran, my grandfather always baked taftoon bread in a clay oven.



Taftoon bread being baked in a clay oven ^[3]

Jamuna: Of course, no problem.

Malaika: We bake pita bread in the oven. It's fun to look through the window of the oven. The bread – how do you say – gets bigger (*showing with her hands how the pita bread puffs up*). At the end, it is like a pocket. We open the pocket on one side and put things inside: salad, tomatoes, falafel and yoghurt sauce.

Alina: Do you know that it's my birthday on Saturday? I'll bring scones, jam and clotted cream.

Malaika: I can't wait to celebrate with you! What are scones and clotted cream?

Alina: Scones are a British speciality – they are little round cakes – and they're really quick to make. And clotted cream is a very thick cream made from cow's milk.

The school bell rings.

Jamuna: Oh, the bell's ringing. What have we got now?

Paolo: Art lesson, great!



Scone with clotted cream and jam

! Stop and draw!

Draw mandalas using ancient Egyptian hieroglyphs, Roman numerals, Hindu-Arabic numerals or other numerals.

Background information: Flatbreads

Chapatis (sometimes called rotis), pita bread and naan taftoon are flatbreads. They are made with flour, water and salt, with or without dry or fresh yeast.

Flatbreads are the very archetype of bread. They are usually baked in a clay oven, in a tava or on a saj (or sac). They are still the most common type of bread in the world. The main advantage is that they are baked very quickly (you do not need much wood, coal or gas) and you just need a hot stone or metal plate to bake them, whereas a loaf of bread requires an oven. What is more, you can use a flatbread as a substitute for a spoon when you are eating!



Chapati in a tava ^[4]



Pita bread being baked on a saj ^[5]

In Lilu's kitchen

SUMMARY

The children try to decipher bread recipes in Arabic, Hindi and Persian. This puts children from countries with Latin writing into a situation that is common for children who are not yet familiar with Latin writing: they are not able to read the text.

LEVEL

●●○ medium

DURATION

2 × 45–60 minutes (more time for making flatbreads)

VOCABULARY

milk products, berries, kitchen utensils needed to bake bread

MATERIAL

- ▶ ingredients for making bread: plain and wholewheat flour, salt, sugar, oil, dry yeast and/or fresh yeast and/or baking powder, etc. (see the recipes in the text)
- ▶ access to a kitchen with stove
- ▶ berries (if the activity is done in late spring/summer) and/or milk products
- ▶ worksheet B – Decoding recipes^[1]

⚠ Safety! Beware of allergies and/or food intolerance and the heat from the stove!

The guests come into Lilu's kitchen, one after the other. Lilu is blowing up balloons for the party. Alina arrives, carrying a tin box with lots of scones. She puts two glasses of jam on the kitchen table as well as a huge bowl of clotted cream.

Lilu: Happy birthday, Alina!

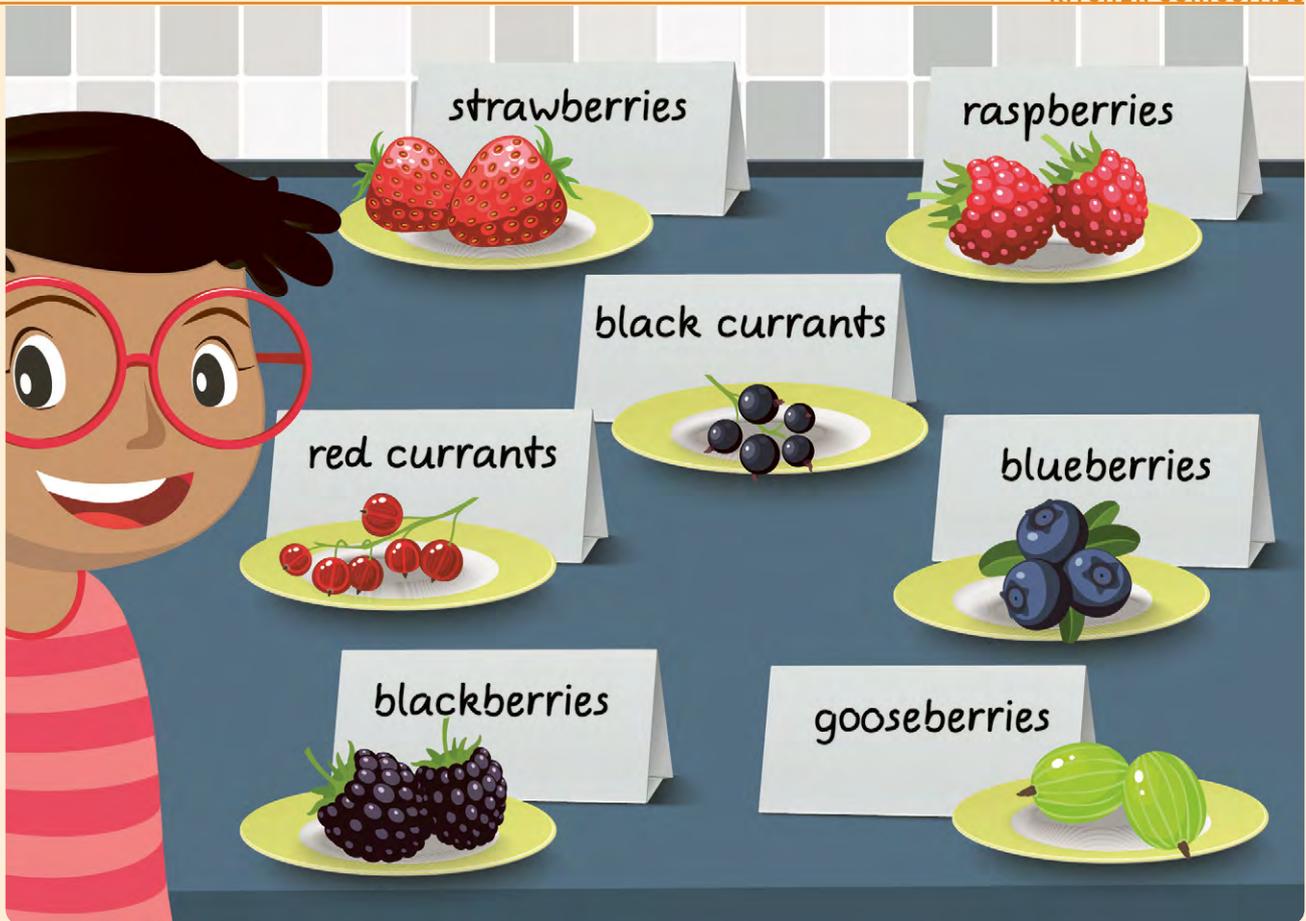
Lilu jumps into Alina's arms, puts his arms around her neck and gives her a big kiss on the cheek.

Malaika, Asal, Jamuna: Happy birthday, Alina!

Paolo, Tom: Happy birthday, Alina!

Alina: Thank you, thank you. I'm so happy to be spending my birthday with you! Here are the scones I promised to bake. I'll show you how to eat them: put a scone on a plate. Take a spoonful of cream – by the way: if you can't get clotted cream, you can just take yoghurt. Spread the cream on the scone – like this – and then add a huge spoonful of jam. Oops, sticky fingers! I brought strawberry and cherry jam, but you can take any jam: raspberry, red or black currant, gooseberry, whatever.





! Stop and jot down!

Make a list of all the milk products you know – everything that is made with milk. And/or: Make a list and describe different berries – both their appearance and their taste.

For the teacher: Milk products: milk, skimmed milk, butter, cheese, yoghurt, cream, whipped cream, sour cream, whey. Berries: strawberry, raspberry, blueberry, blackberry, red/black/white currant, gooseberry, elderberry; more rare berries: cranberry, cloudberry, aronia.

! Stop and try!

The teacher could bring some milk products into class and have the children taste and compare them. If this activity is carried out in late spring or summer, the children can bring berries into class and taste and compare them.

! Safety! Beware of allergies and/or food intolerance!

Lilu: Let's start to make the dough for the different breads – my parents will help us later when we need the stove.

Paolo: Alina, what kind of yeast did you use for the scones?

Recipe for 10–12 scones

- ▶ 500 g of plain flour
- ▶ 1 packet of baking powder
- ▶ 1 tbsp. of sugar
- ▶ 1 tsp. of salt
- ▶ 125 g of butter (soft)
- ▶ 250 g of yoghurt
- ▶ 2 eggs
- ▶ extra flour for working with

Mix the flour, baking powder, sugar and salt. Add the soft butter and mix. Add the yoghurt and eggs. Mix, but not too thoroughly. Preheat the oven to 200 °C. Roll the dough out 2 cm thick. Take a glass and cut out the scones from the dough. Put them on a baking tray in the oven. Bake for 15 minutes. Serve with jam and clotted cream (alternatively: yoghurt).

Alina: I used baking powder. It's a white powder that comes in little packets – look, like this.

Asal: I brought the recipe for taftoon bread. My sister wrote it in Persian.

The others: Oh no, we can't read it.

Asal: Don't worry – she gave me this table to help. Persian writing goes from right to left, but the numbers are written from left to right. You see, this is the word for 'flour' for example. And there it says that we need 200 g of white flour, 100 g of whole-wheat flour, 180 ml of lukewarm water, one teaspoon of dry yeast, 1 tablespoon of olive oil and 1 teaspoon of salt.

Background information: Right-to-left writing systems

Arabic and Persian is written from right to left but the numbers are written from left to right. Hindi is written from left to right.

Malaika: Very interesting, Arabic writing also goes from right to left, and the numbers look almost the same. Look, here's my recipe for pita bread.

Paolo: Oh yes, with the help of the tables we should be able to work out the recipes.

Jamuna: I brought a chapati recipe. My father wrote it – it's in Hindi. I can only recognise the numbers, but the good news is: I know the recipe by heart. And I brought a tava.

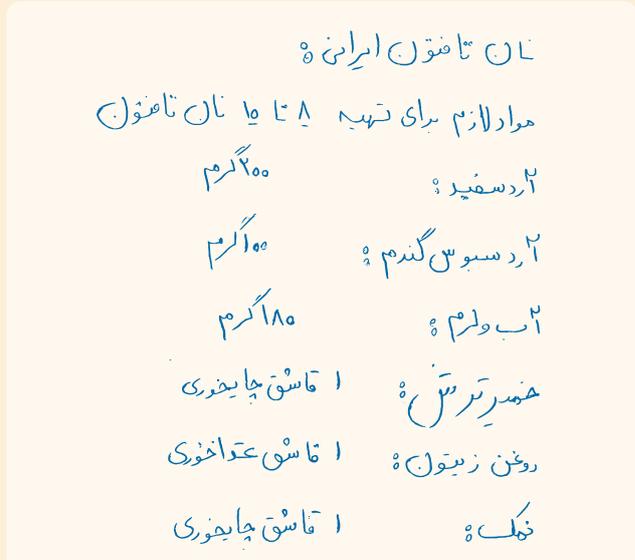


Tava and rolling pin

Stop and decode!

Try to find out what is written in the recipes. Use the assignment tables for numbers and the short glossaries in worksheet B – Decoding recipes. [1]

For the teacher: This activity should be carried out in small groups. If there are children in the class who speak Arabic, Hindi or Persian, they could help their classmates. If a child in the class comes from a country using non-Latin characters, he/she could bring to class a recipe (or another simple text) written by his/her family.



Taftoon bread recipe in Persian

bread	نان	flour	آرد
taftoon	تافتون	white	سفید
Persian	ایرانی	wholewheat	سبوس گندم
ingredients	مواد لازم	water	آب
gram	گرم	lukewarm	ولرم
teaspoon	قاشق چایخوری	salt	نمک
tablespoon	قاشق غذاخوری	olive oil	روغن زیتون
dry yeast	خمیر ترش	10 – 8	۸ تا ۱۰

0	1	2	3	4	5	6	7	8	9
۰	۱	۲	۳	۴	۵	۶	۷	۸	۹

Persian words and numbers with translation for taftoon bread recipe

خبز عربي

المكونات ل ٨ من الضب :-

٢٥٠ غرام طحين

٧ غرام خميرة جافة

١٥٠ غرام ماء فاتر

٥٠٠ ملعقة خميرة ملح

٥٠٠ ملعقة كبيرة زيت زيتون

الوقت: ٦-٧ دقائق في الفرن

Pita bread recipe in Arabic

bread	خبز	water	ماء
Arabic	عربي	lukewarm	فاتر
ingredients	المكونات	salt	ملح
gram	غرام	olive oil	زيت زيتون
teaspoon	ملعقة خميرة	baking time	الوقت
tablespoon	ملعقة كبيرة	minutes	دقائق
flour	طحين	the oven	الفرن
dry yeast	خميرة جافة		

0	1	2	3	4	5	6	7	8	9
٠	١	٢	٣	٤	٥	٦	٧	٨	٩

Arabic words and numbers with translation for pita bread recipe

Lilu: So, what do we need to start baking? You probably all need a kitchen scale and bowls?

Lilu starts to open all the drawers and cupboards in the kitchen and throws out scales, bowls, white and wholewheat flour, salt, oil – the kids are jumping around to catch everything.

Tom: Hey Lilu, be careful! One of the flour bags was open.

! Stop and jot down!

Make a list of the utensils you need for baking bread. Describe what you do with each of the utensils. Example: I use a rolling pin to flatten the dough.

For the teacher: Look in the vocabulary corner^[1] for kitchen vocabulary.

! Stop and talk!

What ingredients do we need to bake flatbread (e.g. pita bread) or scones? Name the ingredients and check the recipes of Lilu's friends.

Asal: I brought all the ingredients I need for the taftoon bread. Lilu, do you have a piece of cling film to cover the bowl with the dough? My dough needs to sit for about half an hour.

Jamuna: I need a rolling pin.

Asal, Malaika: Me too.

Lilu: We also need pans, don't we? Here's a cast-iron skillet – wow, it's even heavier than Jamuna's tava!

Tom: Lilu, please, don't throw it!

Paolo: I brought a block of fresh yeast, smell it. And lots of olive oil and fresh rosemary. My dough also needs to sit for at least half an hour.



Block of fresh yeast and a pile of dry yeast

Tom: I didn't bring a recipe, but I thought we could do some experiments. I was wondering about the different kinds of yeast. I'd like to know what they've got in common and what's different.



Asal: That's true. Why are all these breads made with different types of yeast? And why do we need yeast at all?

Lilu: Without yeast, the bread dough wouldn't rise.

Alina: We could try to find out the best conditions to make bread dough which rises really well.

Malaika: Oh, what a great idea! We can try using dry yeast – we've got so many packets.

! Stop and jot down!

Do you have an idea why yeast makes dough rise? What can you do to get the best rising result? Write down what you think and try to think of an experiment to verify your hypotheses (a hypothesis is what you expect). Do the experiment, observe it carefully and write down your observations. Write a conclusion.

For the teacher: Background information on yeast can be found on → page 49.

चपाती
 मात्रा: ८-९ चपातिया
 सामग्री
 १३० ग्राम चोकर आटा
 ६५ ग्राम आटा
 १२० ग्राम पानी

Chapati bread recipe in Hindi^[1]

Lilu and Alina experiment

Experiment: Playing with dry yeast

SUMMARY

The children investigate the perfect conditions to make a yeast dough rise. They learn that in order to find out what influences this, they have to work systematically: they should change only one parameter at a time. The parameters are: water temperature and amount of sugar.

LEVEL

●●● difficult

DURATION

45–60 minutes

VOCABULARY

words to describe the experiment, past tense

MATERIAL

For each group:

- ▶ 5 packets of dry yeast
- ▶ sugar
- ▶ teaspoon
- ▶ 5 bottles (0.75 or 1 l bottles)

One of the bottles will be filled with [almost] boiling water, therefore it should be a glass bottle. The other four can be plastic bottles.
- ▶ cold, lukewarm and boiling water (to be poured by an adult)
- ▶ 5 balloons (make sure to stretch them a little by blowing air into them one or two times)
- ▶ funnel
- ▶ worksheet C – Writing a protocol ^[1]

⚠ Safety! Be careful with the boiling water!

Jamuna: Lilu, do you have any empty bottles? We could pour yeast and water into a bottle and see what happens.

Malaika: We'll put yeast, sugar and warm water in the bottle, and then we stretch a balloon over the bottle opening. And then let's see what happens.

Tom: Yeah, let's do that.

Lilu: But if we want to find out the best conditions for perfectly rising dough, we have to make comparisons. We should work like real scientists. If we want to know whether it's important to use lukewarm water instead of cold water, we need at least two bottles. In each one, we'll put a packet of dry yeast and sugar. And then we'll add 100 ml of lukewarm water in one bottle and 100 ml of cold water in the other bottle. Then we observe what happens. After the experiment, we'll know if it's

important to take lukewarm water – as is always written in the recipes.

Lilu and the children try out the experiment. They put a packet of dry yeast and a teaspoon of sugar into each bottle.

Asal: Lilu, do you have a funnel? That would make it easier to pour the water into the bottles.

Lilu: Yes, I'll get you one.

Lilu opens a drawer and throws a funnel towards Asal. She catches it and pours 100 ml of lukewarm water into the first bottle and 100 ml of cold water into the other bottle. Malaika then takes two balloons and stretches their open ends over the bottle opening.



Conducting the yeast experiment

⚠ Stop and experiment!

Carrying out an experiment with two parameters: In all the recipes for doughs containing yeast, it can be seen that you are asked to add a small amount of sugar and lukewarm water. Would the dough also rise without sugar? Or with cold water? Or boiling water? Plan an experiment to find out the best conditions for a perfectly rising dough. Make assumptions about the expected results and write a protocol.

For the teacher: Worksheet C – Writing a protocol ^[1] may be used as a guideline for the protocol.

The children face the problem that there are two parameters: the temperature of the water and the amount of sugar. They should change only one parameter at a time, otherwise they cannot draw any relevant conclusions.

This is something they will encounter very often in science classes, as well as in everyday life. This is what could be written under 'How the experiment was carried out':

- Using the funnel, we poured one packet of yeast in each of the bottles.
 - In bottle 1, we added 100 ml lukewarm water.
 - In bottle 2, we added 1 teaspoon of sugar and 100 ml lukewarm water.
 - In bottle 3, we added 2 teaspoons of sugar and 100 ml lukewarm water.
 - In bottle 4, we added 1 teaspoon of sugar and 100 ml cold water.
 - In bottle 5, we added 1 teaspoon of sugar and 100 ml boiling water (we asked an adult to help us).
- We mixed the ingredients in every bottle. We stretched the open end of a balloon over each bottle opening.

⚠ Safety! Be careful with the hot water!
- We observed what happened with the yeast mixtures and the balloons.

This is what could be written under 'Results and explanation':

- Nothing happens in bottle 1: yeast needs sugar and water to produce bubbles (carbon dioxide).
- Nothing happens in bottle 5: If the water is too hot, the yeast has no effect.
- By comparing bottle 2 and bottle 3, you can conclude that the more sugar we added, the more carbon dioxide was produced.
- By comparing bottle 2 and bottle 4, you can conclude that more carbon dioxide is produced when using lukewarm water.

*Yeast is a living organism.
It's a fungus. Yeast needs sugar to grow.
It also needs lukewarm water.
Yeast produces carbon dioxide and alcohol.*

Excerpt of a protocol: conclusion

Conclusion: A mixture of yeast, sugar and lukewarm water produces a gas. This gas is called carbon dioxide (CO_2). If you want to find out what influences your experiment, you should **change one parameter at a time**. In this experiment, the parameters are: the temperature of the water and the amount of sugar.

Background information: Yeast and carbon dioxide

Yeast: Unlike how it seems when dry, yeast is a living organism. Yeast is a fungus. As soon as you add sugar and lukewarm water, the yeast comes back to life: it eats the sugar and produces carbon dioxide – a gas which inflates the balloon. If you add boiling water, the microorganisms in the yeast die. This property of yeast – that it produces a gas – is also the reason why we use it for bread dough. It makes the dough light and airy.

Carbon dioxide, also written as CO_2 , is a gas. It is invisible and it does not smell. It is a natural component of the earth's atmosphere. Without CO_2 in the atmosphere, there would be no life on earth – it would just be too cold. Too much CO_2 however is not good either: we humans emit large amounts of CO_2 into the atmosphere – e.g. by burning fossil fuels (coal, petroleum and gas). CO_2 is one of the greenhouse gases causing global warming.

Hidden sugar in flour: Not only sugar but also flour activates yeast. That means that you do not necessarily have to add sugar to a yeast dough. Flour consists mainly of carbohydrates (e.g. starch, dietary fibres) as well as water and proteins (e.g. gluten). Starch is a polysaccharide (a molecule composed of long chains of simple sugars) which serves as nutrition for the yeast fungi.

*To make a dough rise,
you need yeast, sugar
and lukewarm water.*



Experiment: Float or sink – How do different doughs behave in water?

SUMMARY

The children prepare three different doughs (one with dry yeast, one with baking powder, and one without dry yeast and without baking powder). They test which kind of dough sinks and which one floats.

LEVEL

●●● difficult

DURATION

45–60 minutes

VOCABULARY

words to describe the experiment, past tense

MATERIAL

▶ dough recipes ^[1]

For each group:

- ▶ wheat flour
- ▶ lukewarm water (37 °C)
- ▶ dry yeast
- ▶ baking powder
- ▶ oil
- ▶ sugar
- ▶ tablespoon
- ▶ measuring cup
- ▶ bucket or big salad bowl
- ▶ food colouring (optional)
- ▶ worksheet C – Writing a protocol ^[1]

! Stop and experiment!

Prepare three kinds of dough:

- ▶ Dough 1: Mix 180 g of wheat flour, 2 tablespoons of oil, 2 tablespoons of sugar and 100 ml lukewarm water.
- ▶ Dough 2: Mix 180 g of wheat flour, one packet of dry yeast, 2 tablespoons of oil, 2 tablespoons of sugar and 100 ml lukewarm water.
- ▶ Dough 3: Mix 180 g of wheat flour, 1 tablespoon of baking powder, 2 tablespoons of oil, 2 tablespoons of sugar and 100 ml of lukewarm water.

Use food colouring in order to differentiate the doughs. Take little chunks of each dough and put them into a bucket with water. Which one of the doughs will float, which one will sink? Why? Write a protocol.

For the teacher: Worksheet C – Writing a protocol ^[1] may be used as a guideline for the protocol.

The rest of the dough can be prepared for eating:

- ▶ The dough without yeast is similar to chapati dough. It makes great flatbread. Use a rolling pin to flatten it. Then bake in a heated pan. Flip over after a short while and bake on the other side.
- ▶ The dough with yeast is similar to a dough for bread rolls. Roll into balls of 5 cm in diameter. Let it rise for 20–30 minutes. Bake in the oven for 10–12 minutes at 225 °C.
- ▶ The dough with baking powder is similar to the dough for scones. Roll into a large ball and flatten it out (1–2 cm) on a sheet of baking paper. Scratch the surface with a cross about half way down with a knife. Bake in the oven for 15 minutes at 200 °C.

This is what could be written under ‘How the experiment was carried out’:

1. We prepared three different doughs:
 - ▶ Dough 1: We mixed 180 g of wheat flour with 2 tablespoons of oil, 2 tablespoons of sugar and 100 ml lukewarm water. This dough contains neither yeast nor baking powder.
 - ▶ Dough 2: We mixed 180 g of wheat flour with one packet of dry yeast. Then we added 2 tablespoons of oil, 2 tablespoons of sugar and 100 ml of lukewarm water. This dough contains dry yeast.
 - ▶ Dough 3: We mixed 180 g of wheat flour with 1 tablespoon of baking powder. Then we added 2 tablespoons of oil, 2 tablespoons of sugar and 100 ml of lukewarm water. This dough contains baking powder.
2. We poured the lukewarm water into the bucket. We took one chunk of each dough – all the chunks were the same size. We rolled the chunks into balls. We placed them into the water and waited for a while.



Bowl of water with dough chunks

This is what could be written under 'Observations':

1. At first, all doughs sink when they are placed in lukewarm water. (If the baking powder is very fresh, the dough might not sink at all.)
2. The dough with baking powder rises to the surface first. Bubbles are formed and come out of the dough.
3. The dough with yeast sinks. After a while, bubbles are formed and the dough rises to the surface of the water.

This is what could be written under 'Results and explanation':

1. For the dough with baking powder, the bubbles appear immediately. They change the density of the dough. The chunk of dough still has the same mass but the volume is bigger – this means that the density is lower. The density of the chunk of dough is even lower than the density of water. That is why the dough ball moves to the surface of the water.
2. The dough with yeast sinks first and only rises to the surface of the water after a while because the bubbles are not formed immediately. As opposed to baking powder, the yeast reacts more slowly with sugar and water.
3. The dough without either yeast or baking powder stays on the bottom of the bucket/bowl. Its density is significantly higher than the density of water.

Background information: The chemistry behind yeast and baking powder

The yeast that we use for baking is a fungus. In the warm, moist dough, the fungus and the sugar react to produce alcohol – which evaporates during the baking process – and carbon dioxide. Carbon dioxide is a gas that is also known by its chemical formula: CO_2 . The carbon dioxide in the dough forms gas bubbles which make the dough rise.

Baking powder consists of both an acid [e.g. potassium bitartrate, also called cream of tartar] and a base [mostly sodium hydrogen carbonate]. When baking powder comes into contact with water, the acid and the base react immediately. One of the reaction products is carbon dioxide [$\text{NaHCO}_3 + \text{H}^+ \rightarrow \text{Na}^+ + \text{CO}_2 + \text{H}_2\text{O}$]. Big CO_2 bubbles form.

If the children are not familiar with the concept of density, this is the opportunity to explore it with a practical example. The density is the mass per volume.

Further activities on density

Take two identical plastic beakers. Fill one of the beakers to the rim with sugar. Fill the other beaker to the rim with cornflakes. Both beakers have the same volume (or the same size). Their masses, however, are different. Take a scale and weigh the two beakers. The beaker with sugar is heavier than the beaker with cornflakes. This implies: The density of sugar is higher than the density of cornflakes.



A dough made with dry yeast or baking powder has holes – making it less dense than water. That is why it floats and why the bread is so fluffy and delicious.

Experiment: Doughs with different colours

SUMMARY

The children prepare dough with cabbage juice. They add lemon juice to one part of the dough and baking soda to another part of the dough. They observe the colour changes.

LEVEL

●●○ medium

DURATION

45–60 minutes

VOCABULARY

words to describe the experiment, past tense

MATERIAL

For each group:

- ▶ red cabbage juice or fresh red cabbage (to make your own juice)
- ▶ wheat flour
- ▶ 1–2 lemons
- ▶ water
- ▶ baking soda (sodium hydrogen carbonate)
- ▶ measuring cups
- ▶ tablespoon
- ▶ bowl
- ▶ worksheet C – Writing a protocol ^[1]

Recipe for red cabbage juice

Chop some fresh red cabbage into small pieces (1–2 cm). Put the pieces into a plastic bag and keep it in the freezer for at least 12 hours. Put one cup of the cold cabbage pieces into a bowl and cover with really warm water (does not have to be boiling). Wait for 20 minutes. Stir and pour through a strainer. Ready to use!

The secret to this is: in the freezer, the water in the cabbage cells freezes, destroying the cell walls. When adding hot water, the red cabbage colour is now easily dissolved.

If you have any left-over cabbage juice, freeze it in a suitable container. It stays fresh for at least three months.

! Stop and experiment!

Prepare cabbage juice following the recipe given above. Prepare the dough by mixing 140 g of wheat flour with 100 ml of cabbage juice. Divide the dough into three parts. Add 1 tablespoon of lemon juice to one part and 1 tablespoon of baking soda to another part. Add some more flour or cabbage juice if needed. The third dough is used for scientific control. Observe what happens and write a protocol.

For the teacher: Worksheet C – Writing a protocol ^[1] may be used as a guideline for the protocol. If the preparation of the dough takes too much time, the cabbage juice can alternatively be poured into three identical glasses. Add 1 tablespoon of lemon juice to one glass and 1 tablespoon of baking soda to another. Compare the colours of the different liquids.

This is what could be written under 'How the experiment was carried out':

1. We mixed 140 g of wheat flour with 100 ml of cabbage juice.
2. We divided the dough into three parts. We added 1 tablespoon of lemon juice to one part of the dough and 1 tablespoon of baking soda to another part. We mixed each dough thoroughly. The third part of the dough is used for scientific control.
3. We observed that the doughs changed colour.



Preparation of red cabbage juice



After the experiment: dough with lemon juice (pink), red cabbage juice (purple), and baking soda (blue green)

This is what could be written under 'Results and explanation': We added some lemon juice to one part of the dough and it turned pink. We mixed some baking soda to another part and it turned blue green. This shows that lemon juice is an acid and baking soda is a base. We say: lemon juice is acidic (sour) and baking soda is alkaline – the contrary of acidic.

Background information: Acids, alkalis and pH

The pH indicates how acidic or alkaline a liquid is: pH = 1: very acidic, pH = 7: neutral, pH = 14: very alkaline.

If you add a few drops of cabbage juice to a liquid, the colour changes – depending on the pH of the liquid. Cabbage juice is a pH indicator.

red: pH = 2 = very acidic (e.g. lemon juice)

purple: pH = 4

violet: pH = 6

blue: pH = 7 = neutral (e.g. water)

petrol blue: pH = 8

blue green: pH = 10

green: pH = 12

green yellow: pH = 14 = very alkaline (e.g. liquid drain cleaner)

References

- [1] All additional materials can be downloaded at www.science-on-stage.de/additional_materials_lilus_house
- [2] Ahmed-Yahia-Bouridah / Clémenson / Héliot / Wilgenbus: Wasser auf der Erde, 2011, <https://www.sonntaler.net/aktivitaeten/oekologie/bauen-wohnen/haus-planet-ich/ue4/wasser-auf-der-erde.html> [22/05/2018]
- [3] Caduser2003 / Wikimedia Commons: <https://commons.wikimedia.org/w/index.php?title=File:THAMEES-FURNACE-015.JPG&oldid=163851807> [03/07/2018]
- [4] Dkgohil / Wikimedia Commons: https://commons.wikimedia.org/w/index.php?title=File:Fulka_Roti.jpg&oldid=222440746 [03/07/2018]
- [5] Florian Prischl / Wikimedia Commons: https://commons.wikimedia.org/wiki/File:Bedouins_making_bread.jpg [06/06/2018]



Cabbage juice is a pH indicator. It indicates whether a liquid is acidic or alkaline.



Living Room Marvels

Conceptual introduction

The chapter 'Living Room Marvels' is roughly divided into three parts, which can be done all together or separately.

In the first story, 'Lilu, Alina and the beans', Lilu and Alina discover how beans can jump out of a glass by themselves and other characteristics of legumes (→ page 56). There is also the possibility to cook bean soup with children. This can serve as a transition to the kitchen unit (→ page 36).

In 'Lilu, Alina and the sofa' (→ page 58) a leg of Lilu's favourite sofa breaks. The children can discuss what could make the sofa so comfortable and what would happen if someone sits on the broken sofa. In addition, the children can think about solutions to get Lilo a great sofa again. When Lilo and Alina decide to bring the sofa to a carpenter, they first need to move it out of the living room and through the house. This story is about pushing and pulling the sofa over different surfaces. The children explore the phenomenon of friction and how different conditions – i.e. the type of floor, if the sofa has legs or not, etc. – influence how difficult it is to push or pull the sofa (→ page 59).

In the last part of the chapter, Lilo and Alina want to rearrange the living room but some of the furniture is too heavy for them to move. They decide to make a drawing of what the room should look like. Following the story, children learn how to draw a floor plan of the living room to scale (→ page 60). As plants are often also part of the living room furniture, children discover experiments on requirements for plant growth (→ page 62).

► You can find the plain texts and dialogues as well as the room outline in a printer-friendly version online.^[1]



Lilu, Alina and the beans

SUMMARY

By doing an experiment, the children help Lilu and Alina to find out why the beans suddenly start falling off the windowsill. Furthermore, the children have to find a way to sort different types of beans.

LEVEL

●○○ easy

DURATION

4 × 45 minutes (observation time: 1 day)

VOCABULARY

adjectives to describe beans, food items, utensils, numbers

MATERIAL

worksheet A – The swollen beans^[1]

- ▶ glass jar of different dried beans (e.g. red kidney beans, pinto beans, cannellini beans, borlotti beans)
- ▶ water

worksheet B – Bean soup^[1]

- ▶ computer with Internet connection
- ▶ cooking equipment (e.g. knife, cutting board, pot, spoon for cooking, blender, sieve)
- ▶ ingredients for bean soup (e.g. butter beans, radish, carrots, onions, garlic, butter, tomatoes, broth, water, salt, pepper)

⚠ Safety! Be careful not to cut yourself or get burnt while cooking!

worksheet C – Different sorts of beans^[1]

- ▶ pouch of different kinds of beans
- ▶ sieve

Lilu is sleeping on his sofa. He is dreaming about a nasty, green monster. He is hunting it. He follows the monster into the dark cellar. Then he hears a noise: 'PLOP.' And again: 'PLOP.'

! Stop and jot down!

What might Lilu have heard?





Suddenly, Lilo wakes up. He listens. There it is again: 'PLOP. PLOP.' Is the monster here in the room? 'Nonsense,' Lilo thinks. 'I only dreamed about the monster.' 'PLOP.' Lilo turns on the light. He looks around. 'Why are the beans on the ground? They were in a glass on the windowsill.'

Quickly he calls for Alina to come. Together they watch one bean after another drop out of the glass to the ground. Carefully, Alina reaches for the glass. 'The glass is damp!' Alina says. Lilo comes closer and looks at the glass. How has the water come in? Alina wipes her hand over the windowsill. It is also damp. 'It has probably rained through the gap, and the rain has collected in the glass with the beans.'

! Stop and experiment!

Is it possible that the rain has something to do with the beans dropping from the glass? Help Lilo and Alina to investigate. Use worksheet A – The swollen beans.^[1]

Background information: Dried legumes

Dried legumes can absorb water equivalent to 2.5 times of their own weight while soaking and boiling. This means, if you fill a glass with beans and let them absorb water, the beans will swell up, pushing the beans on the top out of the glass.

Alina and Lilo bring the soaked beans into the kitchen. They have the idea to make a tasty bean soup.

! Stop and cook!

Make a bean soup. You can use the recipe on worksheet B – Bean soup^[1] or you can search for a recipe online. You could also ask a grown-up to teach you about healthy food and good meals. If you want to eat bread with your soup, have a look at the kitchen unit (→ page 43).

Alina pokes around in the closet to find something for dessert. 'Oh, look here!' Alina says enthusiastically. 'Here are lots more beans. Let's see how many types of beans are in this pouch.' 'Could you hand me a sieve please? Then we can tip the beans in it. Maybe we can separate the different varieties like this.'

! Stop and discuss!

Is it a good idea? Do you have another idea?

! Stop and investigate!

Help Lilo and Alina find out how many kinds of beans are in the pouch. Use worksheet C – Different sorts of beans.^[1]

Further ideas for finding out how many types of beans are in the pouch could be to sort them according to their size, colour, shape and feel.

Lilu, Alina and the sofa

SUMMARY

In this chapter, Alina jumps on the sofa, whereupon one leg of the sofa breaks and Alina and Lilu fall down. Afterwards, they try to push and pull the sofa out of the house to a carpenter. In relation to this, the children investigate the effect of friction on different surfaces.

LEVEL

● ● ● medium

DURATION

4 × 45 minutes

VOCABULARY

different surfaces and materials, adjectives to describe the look and comfortability of sofas

MATERIAL

worksheet D – The broken sofa ^[1]

- ▶ counter/game piece
- ▶ doll's house sofas with short and long legs or alternatively build your own sofa with a piece of wood and e.g. matches or bottle corks as sofa legs
- ▶ glue

worksheet E – Push or pull on different surfaces ^[1]

- ▶ different furniture that can be pushed and pulled on different surfaces (e.g. chairs, tables)

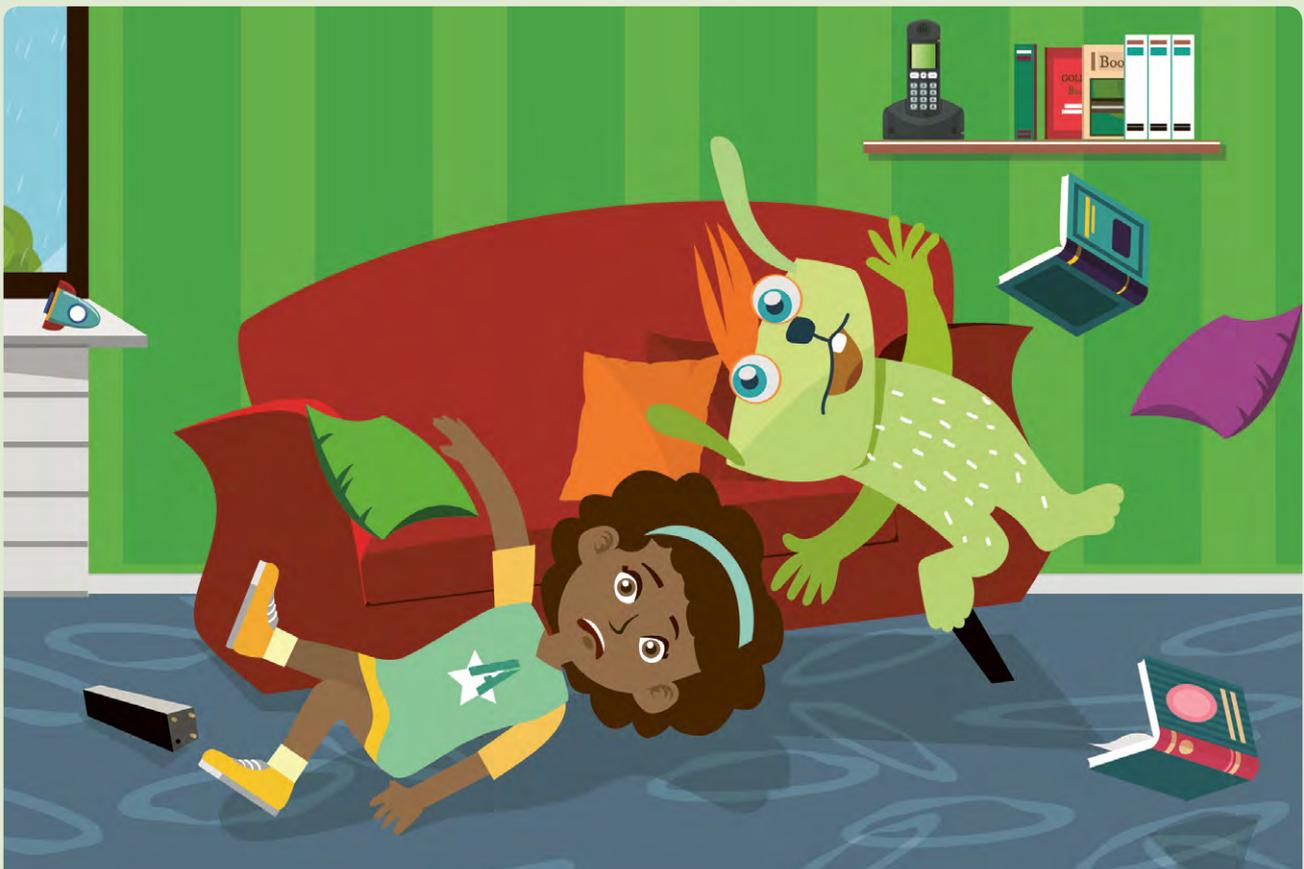
worksheet F – Friction ^[1]

- ▶ wooden board
- ▶ ruler
- ▶ block (e.g. eraser)
- ▶ pen
- ▶ strips of different materials (e.g. tissue paper, tracing paper, leather, sandpaper, plastic)

Lilu is sitting on his favourite sofa. It is wonderfully comfortable. Lilu likes to sit there and read his books all day long.

Stepping

What makes the sofa so comfortable? What do you think?



Word cards

Gather adjectives to describe materials and properties, nouns for components and construction.

Then Alina rushes in. Enthusiastically, she jumps on the sofa, all in a hurry to tell Lilu about her adventures on the playground. Bang! A leg of the sofa breaks. Lilu and Alina tumble to the ground.

Stop and jot down!

Why did Alina and Lilu fall off the sofa? What do you think will happen when Lilu sits on the sofa again? Use worksheet D – The broken sofa.^[1]

Alina looks guiltily down at the ground. Lilu weeps bitterly. His favourite sofa is broken. Where is he going to read now? He wants his super sofa back.

Stop and talk!

What do you think Alina and Lilu can do? Make a drawing and discuss your solution with the rest of the class.

Lilu and Alina decide to take the sofa to the carpenter. He should repair it, so that Lilu can have his favourite sofa back again. Together they try to push the sofa to the door. 'That's so hard! Perhaps we should try to pull it,' Alina says.

Stop and jot down!

What is more difficult: pushing or pulling? Try it out and write down your answer.

Finally, the two decide to pull the sofa through the various rooms to the apartment door. The living room carpet is thick and fluffy, the library has only a short pile carpet. Then there is the hallway with its laminated floor and the kitchen with a tiled floor.

Stop and ask!

Is there something we can explore? How should we do that? Use worksheet E – Push or pull on different surfaces.^[1]

The following things could be explored:

- ▶ Which room would be the most difficult to push or pull the sofa through?
- ▶ Does the manufacturer of the sofa have any influence on how difficult it is to push or pull the sofa through a room?
- ▶ Does it make any difference whether the sofa has legs or not?
- ▶ What materials could the legs of the sofa be made from and does it influence how difficult it is to push or pull the sofa through the various rooms?
- ▶ Is it harder to push a sofa when one of the legs is broken? Why?

Stop and experiment!

Design an experiment to compare friction on different surfaces. You could be inspired by worksheet F – Friction.^[1]

Background information: Friction

The force due to friction between an object and the ground depends on the weight of the object and on the characteristics of the surfaces (meaning the surface texture of the object and the ground). The friction does not depend on the size of the frictional surface. Therefore, it does not make any difference if a sofa has narrow or wide, short or long legs. The friction is the same in all cases.

So which method is easier: pulling or pushing? When pushing the object you press against it – when the object is lower than you, you push downwards slightly. This vertical component of the applied force adds to the weight. When pulling, however, when the object is lower than you, some of the applied force acts upwards, thus reducing the weight. This means: pulling is easier than pushing. Exception: When the applied force acts horizontally, e.g. when you move a big closet, there is no difference between pulling and pushing.

Lilu, Alina and the rearranging of the living room

SUMMARY

In this chapter, the children use their own steps to measure while working with scaling. Moreover, they try to find out what plants need and what characterises them in different parts of the world.

LEVEL

●●● difficult

DURATION

6 × 45 minutes (observation time: 1–2 weeks)

VOCABULARY

measurement, floor plan, furniture

MATERIAL

worksheet G – Measuring with steps^[1]

worksheet H – Furnishing^[1]

- ▶ scissors
- ▶ glue

worksheet I – What do plants need?^[1]

- ▶ two identical plants in two similar pots
- ▶ water
- ▶ tape
- ▶ transparent plastic bag
- ▶ black plastic bag

worksheet J – The plants of the world^[1]

- ▶ copier that can enlarge
- ▶ computer with Internet connection
- ▶ printer

Lilu is looking out the window. Since it is raining, he decides to call Alina and invite her over to play indoors. About five minutes after he hangs up, the doorbell rings. It is Alina. She has been running the whole way, trying to avoid getting wet. But her clothes are so wet that she probably should have had an umbrella or worn rain clothes.

Alina and Lilu go into the living room. 'Sometimes, I just hate the rain,' Alina says, shaking her head trying to get her hair dry. 'Sometimes, I actually love rain,' Lilu says.

! Stop and jot down!

What can we do that is fun in the rain?



'I like to play in the mud and love to jump in puddles,' Lilu says and continues: 'But for now we can stay here and play. What do you want to do?' 'I don't know. What do you think?' Alina asks. 'When my mother gets bored she always rearranges the living room. We could do that.' 'That sounds fun and it would be a nice surprise for your mother when she comes home from work. Let's do that!' Alina says. 'I think we should start with the sofa. Let's put it under the window.' Alina and Lilu start pulling and pushing the sofa, but the sofa does not move an inch. 'Wow, it's heavier than I thought,' Lilu says. 'I don't think we'll be able to move it by ourselves.' 'What about just making a drawing of how we think the room should look like? Then your mum and dad can help us move the furniture when they come home,' Alina suggests.

Lilu finds squared paper and draws a floor plan of the living room. He marks the windows and the doors and draws a sofa in front of the window. 'No, no, it's all wrong!' Alina says.

! Stop and jot down!

What is wrong with Lilu's floor plan (see picture)? Do you have any ideas for making it better?

'The sofa is way too big. If you draw all the furniture that size, there won't be room for it all,' Alina says and continues: 'We need to draw everything to the same scale.' 'How do we do that?' Lilu asks. 'We could use our steps to measure,' Alina says and takes some steps along the sofa while counting 1, 2, 3, 4, 5. 'It is five steps long and almost two steps wide. Let's say that one

step equals the side of a square on the paper. If you cut out a 2×5 rectangle, we have a model of the sofa.' 'That makes sense,' Lilo says and continues: 'Let's use our steps to measure all the other furniture and of course the size of the room.'

! Stop and measure!

Use worksheet G – Measuring with steps^[1] and measure your classroom and all the furniture in it with your steps. Furthermore, you could try to rearrange your classroom on paper. The best way to do this is to cut out paper models for the furniture. The worksheet H – Furnishing^[1] can give you some ideas.

'Done!' Lilo happily says while placing the last chair on the outline of the living room. At the same time, Lilo and Alina hear the front door opening. Lilo's mother is home from work and both children run up to her, eager to tell her about their idea of rearranging the living room.

'Hello Lilo. Hello Alina. What have you been up to today?' Lilo's mother asks. 'We have rearranged the living room,' Lilo says proudly. 'You have what?' Lilo's mother asks, a worried look on her face. Quickly Lilo's mother goes to the living room, but when she looks inside, she seems relieved: 'I think the living

room looks like it did this morning.' 'Yes, we couldn't move the sofa on our own, so we decided to do the rearrangement on paper,' Lilo explains. 'That's a clever idea,' Lilo's mother says. 'Let me look at your ideas then.' Lilo shows his mother their drawing and explains how they made sure all the measurements were to the same scale.

! Science Talk Ball

Help Lilo to explain the measuring using your own words. [Detailed information on this method can be found in the library → page 68]

'What is that?' Lilo's mother asks, pointing to a circle placed behind the door. 'That's one of the plants,' Lilo says. 'That can't be put there. The plant won't get any sunlight, but you can put it here,' Lilo's mother says pointing next to the sofa and continues: 'Think about the needs of plants. If you look on the Internet, you'll find a lot of interesting experiments about the needs of plants.' 'We don't need to,' Alina says. 'I have my own idea to test how the lack of sunlight affects a plant. We only need two identical plants in two similar pots and two plastic bags – one that is transparent and one that is black.'



! Stop and experiment!

What do plants need? Discuss and design one or more experiments to test your hypothesis (a hypothesis is what you expect). You could e.g. test the influence of light, temperature, water or nutrients. For inspiration, look at the experiment on worksheet I – What do plants need? ^[1]

After setting up the experiment, Lilo turns on the TV. By chance, there is a show about plants around the world, which the two children decide to watch. Lilo says: 'Wow, I've never really thought how different plants are. Even though a plant can't speak, its needs actually reveal which part of the world it's from.' 'Yeah, it's so cool,' Alina says and continues: 'Wouldn't it be fun to make a poster that shows how different the plants of the world actually are?' Just at that moment, the phone rings. It is Alina's mother telling her to come home for dinner, but perhaps on another rainy day, the children can make the poster.

! Stop and discuss!

Discuss why the same types of plants do not grow all over the whole world.

Use the Internet to find pictures of different plants from different parts of the world.

You could also make a poster with pictures of plants around the world by getting your teacher to make an enlarged copy of the world map on worksheet J – The plants of the world ^[1] and place images of different plants on the places they are from.

References

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



Library

Methodology for Primary Science Education

Introduction

Lilu, Alina and their friends, who you are introduced to in this booklet, experience a series of adventures connected to science. The story provides children with a context for scientific concepts and apply these to their everyday lives, allowing the children to make connections to the world around them. Therefore, the story offers a hook to engage the children's interest and curiosity, as well as encourage inquiry-based learning, problem solving and trying things out.

Development of scientific process skills using the story

The inquiry-based science lessons, exploring scientific concepts in the story, incorporate a constructivist approach to teaching. By using literacy strategies, they empower the children to think critically, make deep connections through questioning, exploring, thinking, experimenting and reflecting, and applying this understanding in a productive way into actionable knowledge. The story and its associated science activities aim not only to help children make sense of the world around them, but the activities also show how science lessons can be effectively used in promoting literacy through oral language, reading and writing.

The story is written in such a way that the text is divided into manageable sections, allowing the children to read one section at a time. Each section focuses on specific scientific concepts: problems which can be later explored and investigated. Each chapter involves:

- ▶ our characters in a particular scenario in different rooms around a home
- ▶ a particular stage in the story about Lilu, Alina and their friends
- ▶ scientific explorations and experiments
- ▶ reading comprehension strategies and writing as well as oral language development strategies using everyday and scientific language

Development of language skills in science lessons using the story

The main reason for teaching science is to extend children's innate curiosity and their natural urge to explore their immediate environment. Scientists are curious; they seek explanations, therefore science is a way of thinking and doing. It is concerned with asking questions and finding ways of answering them. Science allows children to see an experimental world where everything they encounter can be subject to scientific exploration. The practice and development of key scientific process skills contribute significantly to advancing a child's language, communication and literacy skills and also their mathematical and numeracy skills.

The inquiry-based science explorations and the practice of key scientific process skills, when exploring the scientific concepts related to the story, allow children time to reflect on and apply their learning and concepts across different stories and life situations. All of which are carried out through exploratory talk, dialogue, reading and writing.

Scientific investigations and explorations

When investigating the science around Lilu, Alina and Lilu's home, emphasis is placed on developing a way of exploring and thinking, as well as the practice of scientific skills. Scientific process skills refer to a range of abilities relating to identifying questions, making predictions, designing investigations, obtaining and interpreting evidence, analysing data and arriving at conclusions as well as communicating what has been learned. Such skills are used by scientists to solve problems, i.e. the skills necessary for the effective use of the scientific method. If we are to equip children with the capacity to generate and develop their own ideas, they must acquire certain skills that are central to this process.

These process skills include:

- ▶ questioning
- ▶ observing (looking at the evidence)
- ▶ predicting
- ▶ investigating and experimenting
- ▶ estimating and measuring
- ▶ recording data
- ▶ higher order thinking
- ▶ analysing the information (sorting and classifying, recognising and interpreting patterns)
- ▶ student and teacher questioning
- ▶ collaboration (dialogue)
- ▶ arriving at conclusions
- ▶ communicating

Basic scientific skills

Questioning

Children need practice in asking questions about the world around them. Every science lesson should begin with a question that needs to be answered at the end of the lesson through active exploration and carrying out investigations. Teacher questioning is very important in science teaching, however, encouraging children to raise questions is also very essential in primary science.

For example: Bathroom Wonders – Why is the mirror foggy? (→ page 26)

Observing

- ▶ Careful and precise examination using as many of the five senses as possible
- ▶ Use of simple instruments to extend the senses
- ▶ Selection of observations which are relevant to the current investigation
- ▶ Recording the observations as written descriptions, tables of measurements, graphs or drawings

For example: Kitchen Curiosities – Experiment: Playing with dry yeast (→ page 48)

Classifying

- ▶ Recognising characteristics, similarities and differences
- ▶ Sorting objects according to given properties
- ▶ Explaining clearly the classification system used and why it was chosen
- ▶ Finding the most convenient way of classifying material to achieve a particular purpose
- ▶ Seeing the value of classifications in everyday life, e.g. in dictionaries, in libraries
- ▶ Using established ways of classifying for identification purposes, e.g. sorting and identifying leaves, insects, birds, rocks, etc.

For example: Living Room Marvels – Lilu, Alina and the beans (→ page 56)

Predicting, followed by investigating and experimenting

Children should always predict what they think will happen during an exploration and investigation at the beginning during the exploratory phase of a lesson. They can then plan and

design an investigation to test their prediction. At the end of the investigation, refer them back to their prediction to see if their ideas have stayed the same, changed or have been slightly altered by their findings. This is the ‘Eureka’ moment where the child makes sense of what is being learned.

For example: Bathroom Wonders – Condensation on the mirror (→ page 19)

Estimating and measuring

Measurements always involve comparisons and are never exact. They are dependent on the accuracy of the instruments used and on the skill of the user. Children should have a great deal of practice in the use of instruments, for example rulers, scales and thermometers. They should develop an increasing awareness of the level of accuracy involved.

For example: Living Room Marvels – Lilu, Alina and the rearranging of the living room (→ page 60)

Looking for patterns

This involves ordering observations and recognising patterns of shape, structure, growth and change, collecting data purposefully and organising and presenting it systematically to reveal more precise patterns.

For example: Kitchen Curiosities – Lilu and Alina at school (→ page 38)

Attempting to explain

Asking questions and suggesting explanations are essential features of science, because science is an attempt to provide rational explanations of events and phenomena. Children



naturally want to explain their observations. Two types of explanations are commonly used in science:

- ▶ Making inferences: collecting clues from a situation and deducing a conclusion from those clues. Children often confuse observations with inferences. Observations are statements of observable facts. Inferences are interpretations of observations. Inferences are tentative conclusions and should be made with caution, e.g. 'it seems that ...', 'I think that ...'.
- ▶ Formulating hypotheses: a speculative explanation, a suggestion based on experience and knowledge, or inspired by imagination. When a teacher poses a question about a problem situation, she/he is asking for a hypothesis to be formulated. Hypotheses do not need to be correct explanations, just sensible ones, and the further investigation of such hypotheses may teach the important lesson that hypotheses are only valid if they explain all the observations made to date.

Communication

Science provides good opportunities for the development of communication skills:

- ▶ discussing ideas
- ▶ formulating questions
- ▶ planning experiments
- ▶ descriptive writing
- ▶ tabulation of measurements
- ▶ making models
- ▶ preparing reports/diagrams/maps
- ▶ drama

Language skills

The value of talk in children's learning is well documented. Talk and peer collaboration, children discussing with one another, exchanging ideas and developing their own views, have been shown to contribute to children's development of conceptual understanding in science. Dialogue allows the children to talk about their ideas, helping them to clarify their thinking and to develop their capacity to reason. Conceptual understanding and the ability to use reasoning are central goals of science education. There is a very strong link between the scientific process skills that should be promoted in primary children, i.e. to describe, discuss, predict, explain, hypothesise and analyse ideas, and the use of exploratory talk and dialogue in the classroom. This link can be fostered and utilised in the primary classroom through a variety of different pedagogies included in this book and outlined in the proceeding sections.

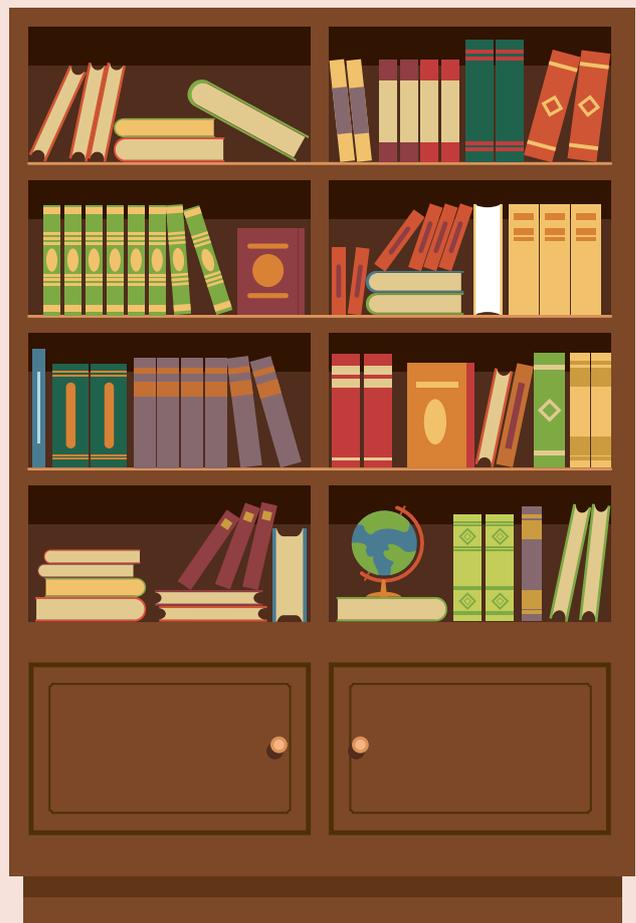
Teachers can:

- ▶ accompany their own actions or those of the children by describing or commenting on them

- ▶ think out loud and use their own thought process as an example of how to gain knowledge
- ▶ encourage the children to think out loud or to describe their thought process
- ▶ provide thinking and learning frameworks ('How can we find this out?', 'Maybe it would help you if...', 'Look at...', 'Maybe think of...', 'What do you need to...?')
- ▶ make learning processes visible ('What did you learn?', 'How did you learn it?', 'What/Who did help you learning it?')

Teachers can also directly and indirectly intervene in the children's talk by:

- ▶ rephrasing (Child: 'Today I went to the ice cream shop. I ate an ice cream. It was very delicious!' Teacher: 'Ah, you went to the ice cream shop today and ate a delicious ice cream.')
- ▶ correcting indirectly (Child: 'I eated an ice cream.' Teacher: 'Ah, you ate an ice cream.')
- ▶ using technical terms (Child: 'I put the water in it with the thing.' Teacher: 'Good, you dripped the water in the beaker using the pipette.')
- ▶ expanding (Child: 'The glass falls.' Teacher: 'Yes, the glass falls and is broken.')
- ▶ thinking out loud ('Tell us how you found out.', 'Please let us know what you think.', 'Explain to us how you know this.')



Storytelling

Storytelling is the main pedagogy underpinning this science teaching booklet. Stories awaken the children's interest and communicate messages, as well as information. Visual and aesthetic content and scenarios and actions in the story arouse curiosity, the observing and questioning mind and the imagination of the audience.

The children can relate directly to the adventures of Alina and Lilu from their own prior experiences and interactions. Throughout the booklet, the children are encouraged to tell or retell details of the story and to describe their observations and thoughts about different details in the story, using words describing actions, feelings and gestures, and descriptive language of the key moments of the story. All the chapters have a clear story line, which allows children to recall descriptions, observations, and factual information.

At different points throughout the story, there are a variety of 'STOP' activities, e.g. time for reflection, sharing of ideas and thoughts. For example, the STOP stations include:

- ▶ **Stop and play!** (game on a working sheet, self-developed game)
- ▶ **Stop and search!** (countries on a globe)
- ▶ **Stop and jot down!** (hypotheses or ideas about an experiment using sticky notes)
- ▶ **Stop and paint!** (experiment setup, characteristics of a bean)
- ▶ **Stop and sort!** (sort different varieties of beans – it helps to define categories according to certain criteria)
- ▶ **Stop and investigate!** (investigate the look and texture of a soaked bean with all the senses so as to be able to draw conclusions)



- ▶ **Stop and discuss!** (discuss possible explanations for a phenomenon)
- ▶ **Stop and experiment!** (experiment on how to clean a bathroom mirror)
- ▶ **Stop and decipher!** (find the quantities in a recipe written in a foreign language)
- ▶ **Stop and talk!** (tell the story in your own words, describe what you are thinking)
- ▶ **Stop and ask!** (phrase a concrete question concerning what you want to know: 'Which ingredient causes the yeast dough to rise?')
- ▶ **Stop and measure!** (distance, temperature)
- ▶ **Stop and research!** (information about Arabic characters on the Internet)
- ▶ **Stop and try!** (taste different dairy products, describe and compare)

Role play

Role play as a pedagogy in science education provides opportunities for children to play out the events they have observed and experienced. It provides evidence of real life situations in which they can practice their learning in problem solving, reasoning, numeracy, communication, language and literacy.

The role play activities in this booklet (→ page 35) promote active, child-centred learning, where the children are interacting with, and relating to the story and science, on physical, emotional and intellectual levels.

Interview and commentary

Getting children to design, plan and conduct interviews is a very successful strategy in reviewing and consolidating their learning and applying what they have learned. The activities for children in this booklet include various tasks, such as commentary on what is happening, e.g. while putting on the sticky dots in 'Bathroom Wonders – Carnival-Dots-Action' (→ page 15). This requires a higher level of language competence, reflection and thought processes.

Word cards

Word cards can be used to help further develop children's vocabulary, reading and writing skills. They can use previously printed out word cards or develop their own word cards as they go through the story and science investigations. They can be used in many different ways to:

- ▶ learn new terms
- ▶ connect words and images
- ▶ sequence events
- ▶ link scientific concepts
- ▶ find similar ideas/matching ideas
- ▶ label drawings or concrete objects

- ▶ sort into verbs, nouns and adjectives
- ▶ form comparatives
- ▶ put together antonyms
- ▶ develop vocabulary
- ▶ help with writing
- ▶ use descriptive language
- ▶ use content vocabulary
- ▶ use science language
- ▶ use everyday language
- ▶ a variety of games can be played with words cards, e.g. 'Snap', 'Dominoes', 'Old maid'

Word wheel

The word wheel is an engaging activity to encourage children to use as much descriptive language as possible. The children close their eyes and imagine an object in great detail. The teacher asks them to describe the object in a certain way, e.g. using as many adjectives as possible. The teacher writes those words in one area of the word wheel. Then the children find as many nouns as they can ('What is the object made of?') and then verbs, and fill the word wheel with them. In the last area, there is space for the beginnings of sentences. In this way, the children have a stock of words and beginnings of sentences which they can use in following lessons.



Science Talk Ball

The Science Talk Ball encourages questioning, discussion and debate in an active and fun manner. The children sit in a circle and throw a ball to each other. The child who throws the ball asks something about the story or the experiments. The child who catches the ball answers the question using terms and words from the word wheel and the word cards.

Mapping and drawing

Children's drawings can be used to create a story map together by drawing the key events of the story. The class can then share their drawings and choose from this collection how to map out the story together. The story 'Living Room Marvels – Lilu, Alina and the beans' (→ page 56) could e.g. be mapped out as follows: Lilu on the sofa; a monster on the cellar stairs; Lilu dreams he follows the monster; etc.

Stepping and story in motion

A story in motion can be carried out after the mapping activity. Now the children step through the moments of the story. They can move and position themselves according to the scenes in the pictures; e.g. 'Living Room Marvels – Lilu, Alina and the beans' (→ page 56): One child lies on an imaginary sofa, yawns and turns. Another child describes what is happening, the emotions Lilu might experience and the gestures he makes.

In another form, the teacher describes actions, gestures and emotions in a very lively way. All the children move accordingly. Subsequently, a child takes over the role of the narrator and may change the events a bit.

The methods described document only a number of activities that can be used to encourage the development of language skills when using stories in science lessons. There are many more. We hope that you will find here useful suggestions for your lessons to engage your students' curiosity and fun in experimenting and talking! If you have any questions or comments, please do not hesitate to contact us via email at info@science-on-stage.de.

Further literature

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Participants

Name	Surname	School/Institution	Country	Teaching Unit
Heidrun	Boll	Berta-Hummel-Schule Bad Saulgau (primary school), Schülerforschungszentrum Südwürttemberg (science centre), BackStageTeam Science on Stage Deutschland e.V.	Germany	Bathroom Wonders
Petra	Breuer-Küppers	Ministry of Education North Rhine-Westphalia, BackStageTeam Science on Stage Deutschland e.V.	Germany	Living Room Marvels, Library, Coordinator
Majken	Grünfeld	Sct. Mariæ Skole	Denmark	Bathroom Wonders, Living Room Marvels
Anna	Gunnarsson	Navet (science centre)	Sweden	Kitchen Curiosities
Jitka	Houfková	Charles University in Prague, Faculty of Mathematics and Physics	Czech Republic	Bathroom Wonders
Maeve	Liston	Mary Immaculate College	Ireland	Library
Kirsi	Rehunen	Saimaanharjun ythenäiskoulu Esikoulu Puuhiset (preschool)	Finland	Bathroom Wonders
Jenny	Schlüpmann	Freie Universität Berlin, BackStageTeam Science on Stage Deutschland e.V.	Germany	Kitchen Curiosities, Coordinator
Mario	Spies	Grundschule Landkern (primary school), Vice chair Science on Stage Deutschland e.V.	Germany	Coordinator
Monica	Zanella	Department of Education for the German Language Group Bozen	Italy	Bathroom Wonders

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Joachim Herz Foundation: Focus on Digital Education



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Experiments, digital teaching concepts, Internet portals with teaching materials, teacher trainings on the use of digital media in the classroom, publications on the current state of research in teaching methodology – the Joachim Herz Foundation stands for this and much more. And importantly: our offers are free of charge, free of advertising and developed together with teachers – for teachers.

STEMdigital – Smartphone Experiments for Biology, Chemistry and Physics

Use a smartphone to analyse spectral lines, understand chemical phenomena using slow-motion images or determine the CO₂ concentration in the classroom. These are just three of the more than sixty experiments currently available on the Internet portal www.MINTdigital.de.

Smartphones and tablets can be used in many ways in STEM lessons. The STEMdigital (German: MINTdigital) teacher portal created by the Joachim Herz Foundation shows how these digital all-rounders can be used in class: from conducting experiments to creating videos and digitally recording student feedback.

LEIFlphysik – the biggest German learning portal

With over 600,000 visitors a month, LEIFlphysik is one of Germany's largest learning portals for students in natural sciences. In 2011 the Joachim Herz Foundation took over the portal from the Munich physics teachers Ernst Leitner and Ulrich Finckh. At www.leiflphysik.de, students can find help all around the topic of physics: with homework, suggestions for experiments or support in preparing for exams. LEIFlphysik offers teachers numerous examples of assignments and interac-

tive boards for physics lessons. The exercises are arranged according to class levels and adapted to the respective curriculum of the 16 German federal states. In numerous animations and interactive modules, physics is presented in an understandable way and can be experienced live. In its design, the portal especially builds on pupils' self-organised learning.

Digital science: Toolbox for teaching

14 examples of the practical use of digital tools in chemistry, physics and biology classes with clear instructions, information on the time required, necessary equipment and materials as well as teaching materials that can be used directly – this is what the 'digital science' toolbox offers. It is available to teachers free of charge. Most approaches are transferable to other subjects. The articles illustrate where and how digital tools can enrich science education. They do not only discuss practical apps and web resources, but also give tips for individual classroom implementation as well as provide further materials.

The Toolbox is just one example taken from the series of publications by the Joachim Herz Foundation Verlag (publishing company) dealing with teaching design and methodology. The complete programme is available at www.joachim-herz-stiftung.de/service/verlag/.

About the Joachim Herz Foundation

The non profit Joachim Herz Foundation largely works operationally and is primarily active in the fields of natural sciences, economics and personality development. In addition, small, innovative third-party projects are supported in these three areas. Since 2017, the foundation has also been supporting research projects in the fields of medicine and law. The Joachim Herz Foundation was established in 2008 and is one of the largest German foundations.

Contact and further information about the foundation, events and publications can be found at www.joachim-herz-stiftung.de/en.

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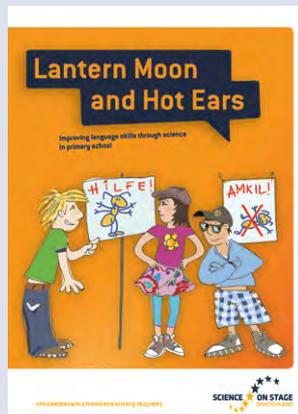
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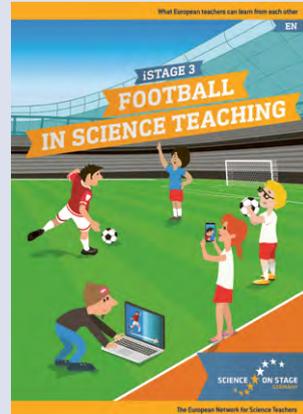
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Further material



Lantern Moon and Hot Ears

- ▶ Improving language skills in primary school through inquiry-based learning using biographies
- ▶ Experiments, worksheets, texts, etc.



iStage 3 – Football in Science Teaching

- ▶ Teaching units about the various aspects of STEM in football
- ▶ Chapters: Biosphere, Body, Ball, Big Data



iStage 2 – Smartphones in Science Teaching

- ▶ Teaching material about the use of smartphones in STEM lessons



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