5.6 States of matter in motion

This STEAM challenge is an adapted version of “How Does Precipitation Sound?” designed to explore changes in the states of matter. The structure of the programs is identical. Both combine science and the arts. In both, the first module focuses on exploring artistic concepts. In the first case, the artistic components are sounds and music; in this version, they are, naturally, movement. We look at the material and observe the movement of the particles. This is followed by the natural science stage, when the student becomes familiar with the scientific content itself - which, in the first case, is precipitation, and in this case, the physics of changing states of matter. The final stage is a combination of physics and art (in this case, motion), presented as a unified whole, which comprehensively develops nearly all of the SPIRIT transversal skills. We considered the development of this adaptation particularly important to demonstrate how a well-functioning structure can be creatively filled with content of a specific subject. And since we cannot provide a STEAMified skills development program for every country’s curriculum, we believe that the implementation of this structure with specific content is an important task for you.

Basic Information Sheet

Age group	Student number	Duration	Number of stages	Subjects connection and relevance
3th grade students	Whole class (max. 30 students)	240 minutes	3 stages	Natural Sciences, Expressive Arts: Movement

STEAM Event Summary

This is a four-hour activity for children aged 9–10 that combines knowledge about the aggregation states and phase transitions with movement. Students combine science into art to explore how water freezes, melts, and evaporates in creative ways. The project develops creativity by challenging children to find expressive movements that represent tiny particles in different states of matter. Children improve their critical thinking as they analyse real-life photos and decide how to accurately translate scientific concepts into physical actions. Teamwork and problem-solving grow as small groups collaborate to choreograph and perform their own unique "movement stories" about phase transitions. This movement-based approach sparks a curiosity and sense of wonder, helping students understand and remember complex natural phenomena through active, hands-on play.

Co-funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them.

SPIRIT Skill Focus

- Problem-solving
- Curiosity, sense of wonder and openness
- Critical thinking
- Creativity
- Empathy
- Resilience
- Flexibility

National Curriculum Link and Objectives

- Art Objective:
  - When moving, consciously make use of the space they or others occupy.
  - Recognize, imitate, and describe the energy in a movement: explosive or controlled. For example: moving like a raindrop on a window as it makes its way down (controlled)
- Science Objective: To describe some natural phenomena related to temperature: expansion and contraction, melting and solidification, evaporation and condensation.
- Cross-disciplinary Objective: The students can transform a certain concept of phase transitions into a movement story

Real-world STEAM Connection and Problem definition

In everyday life, students experience various changes in the states of matter. Ice cream that melts on a warm day, water that turns into ice cubes in the freezer, or steam that fogs up the bathroom mirror after a hot shower are situations children encounter regularly. Yet, they often do not consciously connect these experiences to the scientific concept of phase transitions. In this activity, students first learn to recognize the different types of phase transitions they can observe in everyday life. The ultimate goal is for them to explain these transitions through movement. This creative approach gives their learning deeper meaning: they are challenged to think more critically, which helps them remember the scientific concepts more effectively. By combining science with everyday experiences and movement, this activity makes natural phenomena both tangible and engaging.

Co-funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them.

Materials at a Glance

For the Art Phase:

- Own body

For the Science Phase:

- PowerPoint with current images of everyday phenomena linked to these phase transitions.
- ice cubes, mirror

For the Application Phase:

- Cards with descriptions of phase scenario

Indoor/Outdoor and Classroom layout

Preferably it is an indoor activity. Run it in the classroom, with the possibility of extra space in the corridors or an additional room where students can experiment with/practice the different movements.

Notes on Research-based approach and integration

During the arts-based segment, students engage in open-ended research that stimulates their creativity. They are given the freedom to experiment independently, which sharpens their creative thinking skills. The science segment focuses on scientific concepts, established terminology, and factual knowledge that are systematically taught. This provides a solid knowledge base that students can later draw upon.
The combination of these two approaches – open, creative inquiry and structured scientific knowledge – creates a rich learning process. It culminates in a creative final project where students integrate and apply their knowledge and skills in an original way.

Co-funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them.

Lesson Flow Overview (linked to details below)

Stage	Title	Brief Description	SPIRIT Skills	Duration	Link to Details
1st	**Exploring movements (Expressive Arts)**	The lesson begins with an “artistic part: movement.” Using four pictures of familiar objects or states (melting ice cream, solidified candles, drawing a heart on a “wet” window, and boiling water with steam), the students come up with various movement-related words. We go through the images one by one: • What do you see? • What is happening in the photo? Where? • How does the event in the photo move or unfold? Together, we come up with definitions for each photo: We create a mind map with movement-related words for each image. Photo 1 (Evaporation – floating high in the air, lightly jumping, fluttering, little weight, moving very lightly): FLOATING, RISING, BLOWING, SPREADING OUT, HOPPING Photo 2 (Condensation – small, light, suddenly rolls downward with a lot of energy): FALLING, DESCENDING, SLOWLY SINKING Photo 3 (Freezing – also involves FORCE, requires a lot of muscle tension, going from something liquid to something very hard, moves slowly): TENSE, STIFFENING, FREEZING, STANDING RIGID, SHRINKING	• Critical thinking • Creativity	90 minutes	**STAGE 1 – Exploring movements (Expressive Arts)**

Co-funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them.

		Photo 4 (Melting – the opposite of freezing): RELAXED OR FLOWING, SOFTENING, SPREADING, LENGTHENING, SINKING Next, the students physically act out all these words with their bodies. The teacher or a student demonstrates a specific movement, and the other students imitate it.			
2nd	**Science –state of matter, phase transitions and particle model**	In the science part, students learn about the three states of matter and the names of the different phase transitions through concrete situations and experiences. (see PowerPoint for the different situations and experiences) Each state of matter is visually represented using the particle model. The learned content is synthesized through a board diagram that the students copy.	• Critical thinking • Curiosity sense of wonder	90 minutes	**STAGE 2 – Science –state of matter, phase transitions and particle model**
3rd	**Creative application phase: Science and art**	Linking the concepts of states of matter to our movement mind map: • Under which category of movements do condensation, evaporation, freezing, and melting belong? • Why? • Are the movement qualities complete? Do we need to remove anything? What fits, and what doesn't? • Can we now move as if we are "freezing"? Returning to the particle model in a circle formation: How should we position ourselves for: • Solid? (in a line, next to each other) • Liquid? (mixed together, close) • Gas? (loose, spread out, apart)	• Problem-solving • Curiosity, sense of wonder and openness • Critical thinking • Creativity • Empathy • Resilience • Flexibility		**STAGE 3 – Creative application phase: Science and art**

Co-funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them.

		Now we will practice forming a single solid mass together. We "puzzle" ourselves next to and over each other. Students walk around the classroom; one student stops and forms the solid shape. The others sense that someone has stopped and adjust themselves around that person - without falling, leaning, or supporting each other. Final Phase: The students are divided into groups of four. Each group receives a card showing one of the phase transitions. At first, they are given only the name of the phase transition. (A differentiation option is that they can refer to their own notes, or that the teacher visually presents the corresponding particle models.) The card also includes the substances involved, a depiction of specific states using the particle model, and some movement qualities. The group's task is to turn this card into a movement score, story, or short choreography. The students "read" the information and translate it into movements. They are given 7 minutes to prepare, paying attention to the movement qualities of the state of matter and the particle model. Afterwards, there is a performance moment. Each group presents their movement piece/choreography. The rest of the class tries to guess which substance is being represented and which movement qualities linked to a state of matter they observe.			

Co-funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them.

Tips and Tricks for dealing with challenges (for the whole STEAM program)

- This is very grade-dependent. In a 4th-grade class, the starting point may be that students have already learned about the water cycle in 3rd grade and have already encountered evaporation and condensation (with or without these specific terms). They may also have already done the experiment with the kettle and the mirror. In a 3rd-grade class, this will likely not be the case. They may already have some prior knowledge about the melting point of ice (0°C) and the boiling point of water (100°C).
- In this lesson, we build heavily on what children already know from their everyday life (a melting ice cream, boiling water, condensation on a window/shower/mirror, etc.).

Difficulty level tailoring notes

- All the concepts are quite abstract and must be well understood before they can be translated into movement.
- Not all concepts need to be covered in a single lesson (for example, sublimation can be omitted).

STEAM Program Debriefing and Reflection Questions

- Creativity: In what ways did you manage to produce more movements than you initially thought possible?
- Critical thinking: Which movement best or least effectively represented the phase transition, and why?
- Problem-solving: What challenges did you encounter, and how did you deal with them?
- Wondering: At what moment during the lesson were you most surprised?

Co-funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them.

5.6.2. Stage details and Activities Flow

STAGE 1 – Exploring movements (Expressive Arts)

How does this develop particular SPIRIT skills

Critical thinking and creativity.

What do we want to achieve regarding SPIRIT skill development (student understanding and/or behaviour)?

Critical Thinking (e.g., "What is happening in the photo? How does it move or unfold?")

Children engage in critical thinking by analysing the images and identifying movement patterns related to each scenario. They focus on interpreting the relationship between the object or state and its associated movement, while formulating definitions for each picture. Behaviour:

- Discussing and comparing with peers to identify key details in the images (e.g., "What does melting ice cream look like when it moves?").
- Listening attentively to the teacher's questions and actively participating in defining the movement words (e.g., "It's floating, but how do we describe it?").
- Thinking critically about the movements and contributing their own ideas to the group's mind map.

Creativity (e.g., "How can we move our bodies to represent this?")

Children use their creativity to translate abstract movement words into physical actions. They experiment with their bodies to find ways to express these movements, showing flexibility in adapting to different concepts. Behaviour:

- Acting out the words in creative and varied ways (e.g., "How does floating feel? Let's hop lightly!").
- Imitating movements demonstrated by peers or the teacher, then modifying them to add their own personal twist.
- Collaborating in pairs or small groups, exploring different ways to embody each movement, showing excitement and energy.

Academic/Curriculum Objective connection

When moving, consciously make use of the space they or others occupy.
Recognize, imitate, and describe the energy in a movement.

Materials and tools needed for implementation

4 pictures (melting ice cream, solidified candles, drawing a heart on a "wet" window, and boiling water with steam. Own body.

Preparation notes

No special preparation is required for this phase

Co-funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them.

Guided Questions

- In what way do you see movement in the photo?
- For example, in a photo of a melting ice cube: where is the meltwater going?
- In a photo showing boiling water with steam: where is the 'steam' going?

More specific adapted quided, supportive questions

1. When looking for the smallest, most subtle movement is a challenge:

- Imagine that you are a little drop of water that is just beginning to turn into steam, so slowly and quietly that no one notices! How could you move even more subtly than that—almost invisibly, as if moved by just a tiny breeze?"
- I see that you're moving your whole arm right now. What might it express if, next time, you moved only the fingertips of your little finger very, very slowly?

2. When looking for the biggest, most energetic movement is a challenge:

- How far would you have to stretch, or how would you have to jump, to look like wildly hot, steaming water?"
- If we want to imitate the most intense boiling water, do you think a one-time movement would be enough? What would it mean if we repeated the movement many times with our whole bodies? Let's try it together!"

3. When students don't know how to use their bodies to illustrate the movement of matter

- Let's imagine we're trapped in ice. It's like we're tied up very tightly and can't move at all. How could we become that motionless? How does this tension feel in your body?"
- "Do you think we could also make a wavy, sliding movement on the floor, as if we were liquid water spreading out across the room?"

4. "Who liked this movement?" – Supporting empathy and the expression of emotions

- Let's close our eyes for a moment and imagine this movement again! How did it feel for your bodies to perform it? Was it pleasant, soft, and relaxing, like ice cream slowly melting in the heat, or was it too stiff and tense?
- If this movement were an animal, would it be a cuddly, soft little kitten, or an angry dragon? Ask the person sitting next to you: did they imagine the same animal in their mind, or did this movement bring something completely different to mind for them?

Stage Debriefing Questions (Optional)

Raising Awareness of Critical Thinking and Flexibility

- When you first thought you'd found the subtlest, smallest movement, but then managed to make an even smaller one: how did you figure out the trick?
- What changed in your minds or bodies when you decided to try again instead of giving up after the first solution?

Raising Awareness of Creativity and Resilience:

- I noticed that you tried a wide variety of movements with your bodies until you finally found the state-change movement you were looking for. What did you feel and do when your first movement idea didn't work well? How were you able to come up with a completely new movement?

Co-funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them.

Raising Awareness of Empathy:

- How did you notice within your group when someone really liked a movement, or, on the contrary, when it was tiring or uncomfortable for their body? How were you able to understand each other's feelings without words, just by observing each other's body language? How did you feel when your idea wasn't the one that was accepted?

Tips and Tricks for dealing with stage challenges

- **Challenge** the students to perform larger movements, to carry out the movements more slowly, and to make the movements more clearly (e.g., when rising, they should really make themselves big).

STAGE 2 – Science –state of matter, phase transitions and particle model

How does this develop particular SPIRIT skills

Wondering (This taps into their sense of wonder; students are amazed that water is not lost, but transformed into another state of matter.)

What do we want to achieve regarding SPIRIT skill development (student understanding and/or behaviour)?

Wondering (e.g., "How do these particles move in different states of matter?")

Children engage in wondering by becoming curious about how particles behave in different states of matter. The concrete experiences and visual representations spark questions about the world around them, which leads them to explore and seek answers. Behaviour:

- Asking questions about the particles, such as "Why do particles move differently in solid, liquid, and gas?" or "What happens to the particles when something melts?"
- Showing curiosity by pointing out examples of different states of matter in their everyday lives (e.g., ice melting into water or water vapor rising from a kettle).
- Expressing surprise or excitement when they see the particle model and realize how it represents real-world phenomena.

Academic/Curriculum Objective connection

To describe some natural phenomena related to temperature: expansion and contraction, melting and solidification, evaporation and condensation. To describe gas, liquid, solid.

Materials and tools needed for implementation

PowerPoint with photos of the different phenomena's ice cubes, mirror, electric kettle, etc.

Preparation notes

PowerPoint and worksheet.

Co-funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them.

Guided Questions

- Imagine that you are a tiny water particle! How would you feel if you were trapped inside an ice cube? Would you be pressed tightly together with your fellow particles? And what would it be like to flow through warm water, or to float freely through the air as steam? In which state could you run around most freely, and in which would you be completely trapped?
- Did you notice that one of the phase changes (such as melting or freezing) is missing from our worksheet, leaving an empty space? Which phase change is missing an explanation? If you were the teacher, how would you explain the missing phase change to a robot that has never seen ice or water?

Stage Debriefing Questions (Optional)

- When you were filling out the worksheet, how did you know which drawing corresponded to which state? What was your strategy: did you just guess, or did you look at how closely the particles were packed together and rule out the wrong answers step by step?"
- What was the strangest or most surprising thing you learned today about invisible little particles, ice, or steam? What question about freezing, melting, or evaporation interests you even more now than it did at the beginning of today's activity?
- Was there a moment when someone in your group thought a completely different solution was correct on the worksheet about particles or phase changes? How did you manage to discuss this: were you able to convince each other with arguments without arguing, or did you work together to find the right answer?
- Adaptation of the "biggest hailstorm" question: "What do you think happens to particles if we cool them down *incredibly*, to a temperature much colder than our home freezer? Do they ever stop moving completely? Let's look into this together after class."

Tips and Tricks for dealing with stage challenges

- Consider the students' prior knowledge and personal experiences. It is essential to build on these.
- Use concrete materials (e.g., a solidified candle, water vapor and condensation from a kettle) or highly visual materials that clearly show the different states and transitions. You can also use "moving materials" to illustrate the processes, such as a time-lapse of a candle melting and then solidifying.

STAGE 3 – Creative application phase: Science and art

How does this develop particular SPIRIT skills

- Problem-solving: How to represent the concept with your body while considering the other three group members.
- Critical thinking: Does what they show in their movement accurately reflect the correct scientific understanding?
- Creativity: How can you clearly represent the phase transition through body movement.

Co-funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them.

What do we want to achieve regarding SPIRIT skill development (student understanding and/or behaviour)?

Problem-Solving:
When children have achieved problem-solving skills, you'll observe them:

- Collaborating effectively in groups, discussing ideas on how to represent the concept using their bodies.
- Coordinating movements with their peers, ensuring everyone is in sync and contributing to the overall representation.
- Adapting their movements when things don’t work, making quick decisions to adjust and improve.

Critical Thinking:
When children have reached critical thinking skills, you'll notice them:

- Evaluating whether their movements match the scientific concept (e.g., "Is this how gas particles behave?").
- Revising their actions if they feel something isn’t quite right, showing they are considering accuracy.
- Giving thoughtful feedback to their peers, analysing whether their classmates' movements align with the scientific principles.

Creativity
When children have developed creativity, you'll see them:

- Experimenting with different movements to represent the phase transitions, showing enthusiasm for trying out new ideas.
- Expressing themselves imaginatively, using body language to creatively convey scientific concepts (e.g., fluid movements for melting, stiff gestures for freezing).
- Adding flair to their movements, often incorporating dramatic or playful elements into their performance.

Academic/Curriculum Objective connection

Practice of scientific concepts and movement objectives.

Materials and tools needed for implementation

Cards with terms for phase transitions.

Preparation notes

No special preparation is required for this phase

Guided Questions

Critical Thinking: Does the movement you see accurately represent the given phase transition? Could it be improved to show the transition more clearly?

Co-funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them.

- Transfering it a supporting question - If I were to watch your movement right now, what do you think - would I really feel as if I were seeing water freeze into a hard ice cube, or does it remind me of something else? How about we try to figure this out together: just one of you performs the movement, while the rest of us describe what we see. Then, based on what's been said, we could make a few adjustments to make the transition even clearer!

Empath: Which movements did you find most effective or expressive? Consider the perspectives of others in the group.

- Transfering it a supporting question - Which movement felt the best in your body and muscles when you performed it? Ask each other in your group: did the others feel the same way, or was a completely different movement—like relaxed, gentle flowing or stiff freezing—the most pleasant for them? What do you think—by understanding how each of us feels during the movement, can we choose the best group choreography more effectively?

Stage Debriefing Questions (Optional)

- How did you use your imagination when you had to recreate the change of states (like turning into gentle steam or freezing into hard ice) using your bodies as if you were tiny, invisible particles? What was the biggest challenge you faced while coming up with these movements, and how did you work together to solve it?
- How did you manage to completely forget how you normally move as humans and think outside the box to move like bouncing or tightly packed, vibrating particles instead?
- How did you feel, and what did you do when the others didn't immediately guess which phase transition (like melting or condensation) you were acting out during your presentation?
- How did you manage to quickly adapt and come up with something new without losing your enthusiasm for the game?
- How helpful was it in preparing and ensuring the success of your presentation to try to see yourselves through the eyes of your classmates, who had to guess the riddle just by watching your movements? How were you able to tune in to what they would see and feel?
- How did you feel when your classmates figured out you're the transition story you performed them? How would you describe the feeling of success?

Tips and Tricks for dealing with stage challenges

Have them use the worksheet as well as the corresponding board diagram/notes sheet.

Practice the different phases with the whole class.

Practicing melting (solid → liquid):

- We return to a solid form, standing still and firm, everyone holding hands.
- We are slowly and gently "flow" open, as far as we can, without letting go.

Practicing evaporation:

- We move further apart, becoming more expansive, adding jumps, floating through the classroom, moving from high to low.
- We feel light, moving slowly and smoothly through the space.

Co-funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them.