Promoting the Use of Educational Technology in Learning and Teaching in Science (S1-3) Learning and Teaching Resources

Condensation and Evaporation

Part A: Background and connections	
Topic	Sub-microscopic representations of condensation and evaporation
The relevant theme, topic and learning focus	2.1 Water Cycle − Understand the processes (evaporation and condensation) in the water cycle 6.2 Particle model for the three states of matter − Arrangement of particles in the three states of matter
Prior knowledge	− Water exists on Earth in three physical states − All matter is made up of particles − There are empty spaces between particles − Properties of matter in liquid and gaseous states − Arrangement of particles in the liquid and gaseous states
Previous and subsequent learning activities	− Previous learning activity: *Group laboratory work*: Plotting of a temperature-time graph by measuring temperature changes when pieces of ice are heated to form liquid water and then steam − Subsequent learning activity: *Group laboratory work*: Simulation of the formation of rain

Part B: Details of the learning activity	
Rationale	This learning activity involves the use of a technological platform, DragGame, to support students' consolidation of their skills to develop sub-microscopic explanations for observable, macroscopic happenings. Specifically, students consolidate their understanding of the sub-microscopic representations of matters in different physical states of ***pure*** substances. A good foundation at the current point paves the path for students' subsequent learning of the sub-microscopic representations of phenomena that involve multiple substances (e.g., mixing of alcohol/water, dissolving). The seven principles as specified in OECD (2017) guided the design of the current learning activity: 1. *Make learning and engagement central*: Students' hands-on manipulation, peer discussion, and students' presentation of ideas to the rest of the class are major elements of the activity. 2. *Ensure that learning is understood as social*: Students should be allowed chances to express to classmates and receive feedback from classmates to allow collaborative construction of ideas 3. *Be highly attuned to learners' emotions*: The length of each sub-segment should be sufficient short to allow students' attention to remain captivated 4. *Reflect individual differences*: Guidance and additional challenges are to be provided to the students to ensure students of different learning paces / achievement levels are sufficiently challenged. 5. *Be demanding for all while avoiding overload*: The activity is broken down into two parts to allow a single process

	(condensation vs. evaporation) to be in focus. 6. *Use broad assessments and feedback*: Formative feedback is to be provided to the students through both commenting on the diagrammatic representations and in-class dialogues. 7. *Promote horizontal connectedness*: The learning task is to be connected to daily life experiences (i.e., water on the floor in wet days, condensed water evaporated in the afternoon) that should have been previously noticed by most students. OECD. (2017). *The OECD Handbook for Innovative Learning Environments*. Paris: OECD Publishing.
Learning objectives	*After the current learning activity, students should be able to:* <u>Knowledge</u> - Draw and describe the arrangement of the particles in condensed water on the surfaces and water vapour in the air - Compare the arrangement of particles in liquid and gaseous states - Explain the drying up of the wet surfaces due to evaporation in terms of the locations of water particles <u>Skills</u> - Create diagrammatic representations to provide explanations - Compare and contrast diagrammatic representations - Evaluate the relative merits of different diagrammatic representations through a system of criteria <u>Attitude and values</u> - *Perseverance*: Demonstrate courage in the face of difficulties in the completion of given tasks - *Respect for others*: Maintain friendly and peaceful relationships with peers that hold different views in discussion - *Commitment*: Demonstrate the will to improve persistently after receiving feedback on their work
Segment time	40 minutes
Materials	Worksheet 1 tablet computer per student (or pair/trios of students) DragGame activity, available at: https://draggame.e-learning.hk/en/templates/294/view/

Part C: Implementation	
Lead-in	5 minutes; whole class - <u>Transition</u>: A photo that shows the wet floors and walls during a humid day is shown to the student. Questions are posed to require students to describe the picture in terms of water (* NOT water particles). - <u>Framing question</u>: How can we represent the water in the classroom during a humid day in a sub-microscopic manner? - <u>Instruction</u>: Students are shown how the DragGame platform

	could be accessed (possibly by taking a snapshot of a QR code), what the circles mean (i.e., particles), and how the circles could be manipulated.
Development	30 minutes: individual work + group work + whole class *Part 1: Explaining condensed water on the surfaces (17 minutes)* – Group discussion: (2 minutes; group work) Students discuss the two questions in part 1 of the worksheet – Individual/pair manipulative task 1: (3 minutes; seat work) Students individually drag the particles in the appropriate positions in the given activity on the DragGame platform – Group discussion 1: (3 minutes; group work) Students describe their pictures to their peers and explain why they arrange the particles in such a way. – Individual/pair manipulative task 2: (2 minutes; seat work) Students adjust their DragGame representation individually after the previous group discussion. – Whole-class discussion 1 (7 minutes; whole class) *Dialogic prompts to be used:* 1. Can you describe the diagram that you have drawn? 2. Can you share why you arrange the circles in such a way? 3. Can you compare the two diagrams here, pointing out the similarities and differences? 4. What has been well-represented in these two diagrams? 5. How would you change the arrangement of circles in the diagram(s) to improve the representation? 6. Why do you make these changes? The teacher subsequently highlights the key features of accepted representation. *Part 2: Explaining evaporation (13 minutes)* – Whole-class discussion: (2 minutes; whole-class work) 1. Question: While the floors and walls are usually wet in the spring mornings, sometimes they become dry in the afternoon, even if we do not wipe these surfaces. Why? Can you explain in terms of water? [*The water on the walls and floors goes into the air.*] 2. Instruction for the students to access the second DragGame task. https://draggame.e-learning.hk/en/templates/283/view/ – Individual/pair manipulative task 3: (2 minutes; seat work) Students individually drag the particles in the appropriate

	positions in the second activity on the DragGame platform - Group discussion 2: (2 minutes; group work) Students describe their pictures to their peers and explain why they arrange the particles in such a way. - Individual/pair manipulative task 4: (2 minutes; seat work) Students adjust their DragGame representation individually after the previous group discussion. - Whole-class discussion 2 (5 minutes; whole class) *Similar dialogic prompts are to be used.*
Debriefing	7 minutes, the whole class - Summary: The teacher could ask reflective questions now, e.g., 1. "What have we learned in this lesson?" 2. "How could condensation be represented in a sub-microscopic way?" 3. "How could evaporation be represented in a sub-microscopic way?" - Remarks: The teacher could highlight the differences between evaporation and boiling from a macroscopic perspective. - Transition: Evaporation and condensation are two important processes in the water cycle. Yet, they involve the same substance, water. Therefore, they involve one type of particle only. However, many daily life experiences involve multiple kinds of substances. It will be the focus of the subsequent lesson.

Part D: Extensions	
Possible adaptations / extensions / modifications	- Questions for groups that complete the tasks faster than the others: *[These could be included as "Challenges" on the worksheet.]* 1. *(For part 1)*: The temperature in spring and autumn is more-or-less the same. However, why is the classroom floor often wet in spring mornings but not in autumn mornings – How do you explain that in terms of particles if you are using the DragGame platform to explain the difference? [*Autumn mornings are less humid, with fewer water particles in the air than spring mornings.*] [*I* would not place any circles on the surfaces*, and all circles should be in the blank space in the middle.*] 2. *(For part 2)*: Evaporation of seawater is a way to produce salt in some places. Why does the method work – Can

	you explain in terms of particles? How can you use DragGame to aid your explanation? [*Water particles left the surfaces while salt particles remained. (At the junior secondary level, the mentioning of ions and lattices is not necessary.)*] [*In DragGame, I would include two kinds of circles, such as black and white. One type of particle (e.g., shown by black circles) should be regularly arranged and left on the surfaces; while another particle will be in the air.*] - Questions for groups that require more help: *(Guidance to be provided orally and individually)* *For part 1:* 1. What is the state of water on the walls and floors? How can we represent them in terms of particles? [*Liquid.*] [*They should stick on the surfaces, close to each other, yet irregularly arranged.*] 2. The relative humidity on spring days is usually around 90%. So, do you think there is water in the air? [*Yes, otherwise, the relative humidity will be 0%.*] *For part 2:* 1. When we cannot see the water on the walls and floors, what is the state of water now? [*Gaseous state*] 2. Where are the water particles now? [*In the air*] - Other possible modifications: Students could be given a picture of the water cycle *in lieu* of this task or additionally work on the DragGame task to represent the state of water in the cloud, in the sea, and the air.
Assessment	Formative assessment using the drawings in DragGame, in which students receive feedback on the following: Drawing in part 1 - Location of the circles (denoting "water particles") *([a] On the walls and floor, and [b] in the air)* - Distance between the circles *([a] Circles closely held and close to each other on floor and wall, and [b] well separated apart in the air – Circles in the air should be further apart than those on the surfaces)* - Arrangement of the circles *(No fixed arrangement for all circles)* Drawing in part 2 - Location of the circles (denoting "water particles") *(most if not all circles are in the air; isolated particles allowed on the surfaces permitted, yet the number should be fewer)*

	- Distance between the circles *(well separated apart)* - Arrangement of the circles *(No fixed arrangement)* Note (for part 2): It is NOT required that the total number of particles should be the same before and after evaporation, as the DragGame images in this activity provide only partial pictures of an open system. However, if the students explain in terms of conservation, the teacher does not need to intervene as any partial pictures could show the conservation of matters *by chance*.