Working Together: Investigating the Formation of Ant Trails

Secondary: ages 11-14	Biology: Animal communication

This unit provides students with opportunities to engage with different modelling approaches as they investigate the complex phenomenon of ant trail formation. Students learn how ants communicate using pheromones and explore the variables effecting food collecting efficiency using several computational modelling tools.

Time allocation	About 3 lesson periods
Subject content	Develop and use models to explain how factors related to pheromone communication effect the efficiency of ants' food collection from the environment to the nest.
Creativity and critical thinking	This unit has a **creativity** and **critical thinking** focus: • Constructing, evaluating, revising and using different models • Observing and exploring real-life ant trail formation • Engaging with several computational modelling tools to make sense of phenomenon
Other skills	Collaboration; Communication; Computational thinking
Key words	Modelling; Ant communication; systems thinking

Products and processes to assess

Students produce observations and questions related to ants' trail formation and construct drawn and computational models to explain factors effecting the efficiency of ants' food collection. They present, evaluate and revise their own and their peers' models. At the highest levels, their work examines a wide variety of ideas, considers and questions several ways of answering the problem and shows a clear understanding of the strengths and limitations of the models and explanations produced.

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Teaching and Learning plan

This plan suggests potential steps for implementing the activity. Teachers can introduce as many modifications as they see fit to adapt the activity to their teaching context.

Step	Duration	Teacher and student roles	Subject content	Creativity	Critical thinking
	(Preparatory phase)				
1	Lesson period 1 (approx 3 hours)	Students perform outdoor observations of ants' trails or watch a video of ants forming a trail to collect food. After this, students are asked to write their observations and generate their own questions related to the phenomena. The class sort their questions into categories e.g. unusual or surprising questions, questions they are most curious about etc., explain their choices, and generate additional questions to fill each category. Following this, students in small groups draw models to explain how ants collaborate to form the trail. Then, students plan and conduct an investigation to test each of the models by observing or manipulating ant trails they find in the outdoor environment.	Students are introduced to the phenomena of ant trail formation. Students draw models to explain their ideas about ant communication. Students plan and conduct investigations to explore their ideas.	Observing and engaging with real-life phenomenon to find patterns and ask questions. Producing and presenting investigations and drawn models.	* Reflecting on observed phenomenon of ant trail formation. * Evaluating self and peer drawn models.
2	Lesson period 2 (approx. 3 hours)	Students investigate the factors that impact the ants' trail formation. An adaptation of the "ants" model in NetLogo model (Wilensky, 1999) provides blocks of computer code in the form of widgets where the student could choose among several rules for the ants and the pheromones. They also set different variables in the model, such as the number of ants. Students are given a printed guide that introduces the interface and its tools and provides questions that help students focus on various processes in the model. Students can be encouraged to share their experiences with the model with each other and ask each other questions about the choices they have made	Students use computational models to investigate factors that influence ant trail formation.	Using computational models to test their ideas.	* Evaluating explanations about ant trail formation by simulating ABM computational models. * Considering different perspectives on the modelling process
3	Lesson period 3 (approx. 3 hours)	Students are introduced to SageModeler, a system dynamics tool, where they are asked to revise a partially constructed model, to add additional variables, and to test the model based on their understandings and hypothesis. Students run a simulation of their	Students construct, revise and evaluate SD models to present their understanding of ant trail	Constructing and revising computational	* Evaluating explanations about ant trail formation by simulating ABM

	model and produce graphs that demonstrate the effect of changing the variables they added to the model on the amount of food in the nest and evaluate and revise their model. In the final part of the lesson, students reflect on the unit itself in a whole class discussion. They discuss the affordances and limitations of the different modeling tools and how each modeling tool can be used to investigate different aspects of the ant trail formation and pheromone communication phenomena.	formation based on their prior investigations. Students engage in summary discussion about ant communication and the different modelling approaches.	models to test their ideas.	computational models. * Reflecting on steps taken to solve a problem

Resources and examples for inspiration

Web and print

- Detailed description of the ant communication unit available at: https://doi.org/10.1007/s10956-020-09869-x

Other

- NetLogo open-acccess software available at: http://ccl.northwestern.edu/netlogo/
- SageModeler open-access software available at: https://sagemodeler.concord.org/app/

Creativity and critical thinking rubric for science

- Mapping of the different steps of the lesson plan against the OECD rubric to identify the creative and/or critical thinking skills the different parts of the lesson aim to develop

	CREATIVITY Coming up with new ideas and solutions	Steps	CRITICAL THINKING Questioning and evaluating ideas and solutions	Steps
INQUIRING	Make connections to other scientific concepts or conceptual ideas in other disciplines	1,2,3	Identify and question assumptions and generally accepted ideas of a scientific explanation or approach to a problem	1,2,3
IMAGINING	Generate and play with unusual and radical ideas when approaching or solving a scientific problem	1	Consider several perspectives on a scientific problem	2
DOING	Pose and propose how to solve a scientific problem in a personally novel way	1,3	Explain both strengths and limitations of a scientific solution based on logical and possibly other criteria (practical, ethical, etc.)	1,2,3
REFLECTING	Reflect on steps taken to pose and solve a scientific problem	1,2,3	Reflect on the chosen scientific approach or solution relative to possible alternatives	1,2,3