FONDATION
La main à la pâte
POUR L'ÉDUCATION À LA SCIENCE

Classroom Sequence

Step 1: How to clean a dirty water sample

Water, a rare resource to be protected (1/3)

Chemistry - mixtures and solutions
4th – 6th grade

Introduction

Topics covered	**Chemistry, mixtures, separation techniques (filtration, decantation, distillation), dissolution, water treatment plant.**
Summary and objectives	During this step, the students will apply their knowledge of mixtures and carry out an experimental approach to separate a complex mixture (dirty water).
Discipline engaged	Science and Technology
Duration	1 h 30 approx.

This resource compiles work done by teachers in the *La main à la pâte* networks. The three stages of the water sequence can be carried out independently. We encourage teachers to create their own progression, adapted to their students and the time available.

To help teachers choose from the proposals, here is the order in which the activities were designed:

Step 1: How to clean a dirty water sample
Step 2: Discovering how a wastewater treatment plant works
Step 3: Is clear water safe to drink? Is it pure?

Getting started

This resource is a follow-up to the compiled resource "Discovering Mixtures". Do not hesitate to watch the videos Billes de science #7: Tania Louis- Mélanges de liquides (Mixtures of liquids), and Billes de science #3: Tamar Saison-La Dissolution (Dissolution).

Disclaimer: These videos are in French. But we encourage you to activate the English subtitles. Just be aware that this is an automatic translation.

Lexicon

Filtration: separation of the components of a mixture using a filter.
Decantation: the heavier components of a mixture fall to the bottom of the container under the effect of gravity. This creates two phases that can be separated.
Distillation: the mixture is heated. The vapors that escape from the mixture are collected and cooled to obtain a liquid.
Separation techniques: allow a mixture to be transformed into several distinct components. Examples include filtration, decantation and distillation.
Wastewater treatment plant: a facility designed to purify (clean) water before it is released into the environment. This water will be collected again downstream for distribution.

Activity: Cleaning a dirty water sample

Main objective: Come up with possible solutions and use an experimental approach to verify them.

Summary	
Discipline	Science and Technology
Procedure and method	Students discuss possible ways to clean dirty water and conduct experiments to verify their hypotheses. The teacher guides them in their experimentation.
Duration	1 hr 30 min
Material	For the class: • Clear plastic and glass containers, funnels, filter paper, spoons, sand, sieves (e.g., fine mesh or vegetable netting), hot plates and oven mitts, dishwashing liquid or disinfectant, pieces of cloth, syringes without needles (depending on availability in class and age of students), pipettes (depending on availability in class) For each group of students: • Dirty water samples, made by the teacher or collected in nature (see educational note).

Takeaway
To make water clearer, you can: • **decant** it by letting the impurities settle at the bottom of a container; • **filter** it by passing it through a filtering material; • **distill** it by heating it and recovering the steam obtained.

Educational note:

- To create a dirty water sample, large pieces of waste are ideal, such as leaves or gravel, as well as water-soluble dirt, such as soil, which also colors the water. The teacher can also collect water from a puddle.

Possible procedure

Phase 1: Starting the conversation (5 min)

The teacher places bottles of dirty water in front of each group of students and asks them, "*What is in these bottles?*" Possible answers from students are that the bottles contain dirty water, dirt, mud, etc. The teacher discusses with the class: "*Can you wash your hands with this liquid? Why? How can you make this liquid 'clean' to use?*" The teacher explains to the pupils the work to be done. The students must find one or more ways to clean this dirty water sample in order to obtain "clean" water that would allow them to wash their hands.

Educational note:

- It is important that the samples be shaken, so that the students can observe the settling phenomenon during their trial-and-error phase.

Alternative:

- The teacher can add some context to this session by telling an introductory story to the students: "*During a walk in the forest, you slip on a muddy embankment because it rained the week before, and your hands are dirty. You would like to wash your hands, but you don't want to use the water bottles in your backpack. You see a puddle a little further on, which is unfortunately dirty. In your rucksack you have cloth, cups, a spoon, disinfectant, a stove, a mesh potato bag and potatoes, a duvet and a box of matches. You then decide to clean this water so that it is clear and you can wash your hands with it.*" The teacher provides each group of students with a sample of dirty water.

Phase 2: Formulation of hypotheses (5 to 10 min)

The teacher lets the students think independently about hypotheses that could answer to the question. They can go to the equipment table to observe what is available to them and take notes in their science notebook, in the form of key words, diagrams or sentences. The teacher makes sure that the pupils have understood the work to be done. This time for coming up with hypotheses is done alone, in order to encourage reflection and to allow the children to grasp the subject at their own pace. After a few minutes (left to the teacher's discretion), the pupils form groups of three or four and share their hypotheses. The teacher circulates between the groups and helps them to agree on the experiments to be carried out first. The students will not necessarily have time to test everything. They may discover other experiments proposed by their classmates during the pooling phase.

Alternative:

- The teacher can also choose another approach during this hypothesis-forming phase. He/she can ask the students, *"What materials do you think you will need?"* The children list the possible materials needed to clean the dirty water. The teacher then takes out the material listed by the pupils, if he/she has it, or explains why he/she does not have it (dangerous product, unavailability of this type of material at the school, etc.). He/she gets the pupils to name it, if it is known, or names it. Other objects than those mentioned by the pupils can be presented by the teacher. The material remains available to the children throughout the activity.

Phase 3: Experimentation and validation of hypotheses (30 min)

Students conduct the experiments. They can filter the water using mesh screens or vegetable nets, and thus retain large debris (pebbles, leaves). However, the water remains quite dirty. The students can then imagine filtering the water with cotton, sand or other filtering materials.

Some will try to scoop out the debris with a spoon, but this method is time consuming, tedious and does not produce the desired results.

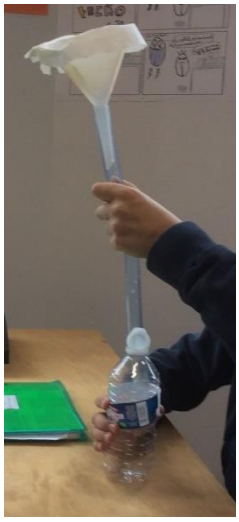
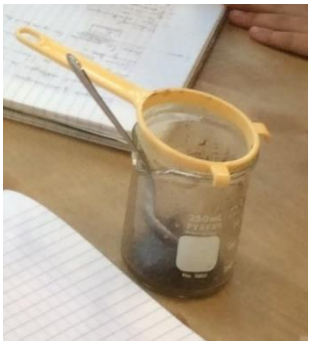
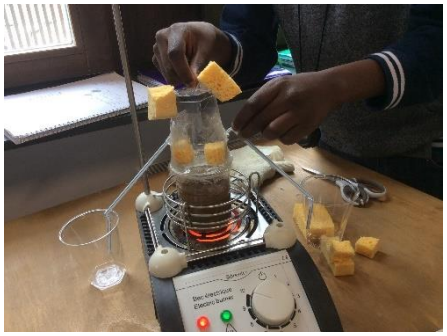
Other students may think of adding dishwashing liquid, bleach (although this should be avoided in class) or some other cleaning product to the water, but the result is not satisfactory. A discussion with the teacher can help students understand that "cleaning or washing" water is not the same as "cleaning or washing" their hands or body.

It is possible that some students think of heating the dirty water and find themselves at the end of the experiment with dried sludge. A discussion with the teacher leads them on the path to distillation. If the students do not go down the path of distillation, distillation will be presented in the lesson review phase.

Educational note:

- Some schools do not have the necessary equipment to carry out distillation. In this case, the principle of distillation is approached with the help of an animated video such as that one (until 1'40''): https://www.youtube.com/watch?v=xRGR5ZvO3AU

In the course of the session, students often stumble upon decanting, as they can observe their sample resting during the reflection phase. To collect the clear water above the sludge and impurities, they may suggest scooping with a spoon or glass, depending on the size of the sample. They can also use a syringe or, if the sample is in a plastic bottle, drill a hole where the clear water separates from the waste and transfer it to another container.

Separation techniques used by sixth grade students to clean water.
From left to right: filtration using a paper filter,
filtration using a kitchen strainer,
home distillation.

Pooling and conclusion (10 to 15 min)

At the end of the experimentation phase, the teacher asks each group's leader to bring their clean water sample and present the procedures they used to the whole class. The students can then observe and compare the samples of their classmates.

The teacher discusses with the children the best technique for making dirty water clear.

If the students have not thought of distillation, the teacher briefly presents the principle, using the video https://www.youtube.com/watch?v=xRGR5ZvO3AU in order to introduce this technique, which is not as easy to find by trial and error.

The teacher concludes the activity by asking the students if they can wash their hands with the water obtained and encourages them to justify their answer. Here is an example of a written record following this exchange: "*We came up with some ideas about how to clean dirty water samples and then verified them by conducting an experiment. To effectively clean dirty water, we need to separate the components of the mixture. We can filter the dirty water using a coffee filter, sand or cotton, for example. We can also distill it, which consists of boiling the dirty water and recovering the steam in another cooled container, so that it becomes liquid again. Finally, we found that if we let the water sit for several minutes, the waste falls to the bottom of the container. This separation process is called decantation.*"

The teacher can also introduce the following steps, asking whether the water obtained is drinkable or not. The teacher asks the students: "*What steps or procedures would need to be added to the protocol in order to make the water drinkable*?" The children can talk about the water treatment plant or the water in swimming pools, or even the tap water that smells like "chlorine." This extended discussion is optional and it may be difficult for students to connect their experiments to the larger scale of water treatment.

Evaluation exercise

Emmanuelle wants to drink orange juice without pulp. In her kitchen, she squeezes an orange. In the juice obtained, there is some pulp that she does not like.

How do you get orange juice without pulp? Write an account of what you would do if you were Emmanuelle.

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