Microplastics: small but deadly

Try these activities to demonstrate the hazards of plastic waste in our oceans.

Image courtesy of Maria Teresa Gallo/Scienza under 18 Isontina

By Giulia Realdon

While sailing in the Arctic as a 'Teacher at sea' in 2014[w1], I first heard about the problem of microplastics – fragments of different polymers, all smaller than 5 millimetres in diameter, that are now found in nearly every environment. Worryingly, due to their small size, marine microplastics are eaten by zooplankton and so enter food chains, producing a new type of marine pollution.

Back at home, I shared my experiences with colleagues at the association *Scienza under 18 Isontina*[w2] and together, concerned about this emerging environmental problem, we developed new teaching activities on microplastics to be presented in Italian schools during UNESCO's sustainability week in 2014. This article details these practical experiments and drama activities, suitable for students aged 3–16.

Going fishing

In this drama activity, young pupils (aged 3–7) act out the story of how microplastics find their way into our food. Full details of the activity can be downloaded from the *Science in School* website[w3].

Introduce the story of John and Mary, who live in a small house near the sea. They go fishing every day to find food to eat and one day, they throw lots of plastic rubbish into the sea. What happens to it? The pupils act out how the sun, wind and waves break the plastics into tiny pieces: microplastics. The pupils then pretend to be small fish that eat the microplastics, larger fish that eat the smaller fish, and a tuna fish – played by one pupil – that eats the larger fish, together with all the microplastics. To John and Mary's surprise, when they catch the tuna fish and take it home to eat, it is full of tiny pieces of plastic!

To conclude the activity, the children discuss how to avoid microplastics polluting the sea. For example:

REVIEW

- ✓ Biology
- ✓ Chemistry
- ✓ Ecology
- ✓ Organic chemistry
- ✓ Ages 3-16

The article describes several activities to introduce students to microplastics, tiny plastic particles, and their impact on the marine environment.

One is a drama activity for very young pupils about how microplastics find their way into the food chain. Role-playing can help children to better understand the processes that these plastics are involved in and why they are so dangerous. Other practical activities described in the article involve materials (e.g. sand, cosmetics, personal-care products, bottles, and plastic bags) that students are familiar with, which can help to raise interest in microplastics and the effect they can have in ecosystems. All the materials required for the experiments are readily available and the instructions are easy to follow, making the activities suitable for students to perform in small groups.

Finally, the text could be used as a starting point for discussing the consequences that the consumption of certain products can have on our environment. The discussion can help students to be aware that simple actions can make our lives greener and reduce our impact on the planet.

Mireia Güell, Spain

- Do you like eating fish? If so, what is your favourite fish to eat?
- What happened to the plastic objects that John and Mary that threw away – how did they turn into the small bits of plastic that the fish ate?
- Should we eat fish? What are the benefits and disadvantages?
- People do not normally throw their rubbish directly into the sea. So how does so much plastic end up in the sea?
- How should we dispose of plastic objects in a better way? (Show the pupils a bin for collecting plastic waste separately. Explain that many plastics can be recycled.)

Exploring plastics

This is a practical activity for students aged 8–16 that investigates the characteristics and uses of different household plastics. The class works in small groups of 2–4 students.

Materials

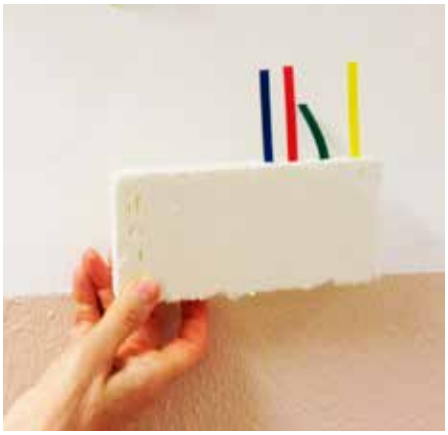
For the whole class:

- 0.5 l acetone
- Small polystyrene block (about 10 cm x 15 cm x 5 cm)
- Hairdryer
- 1 l of diluted rubbing alcohol (40% rubbing alcohol by volume)

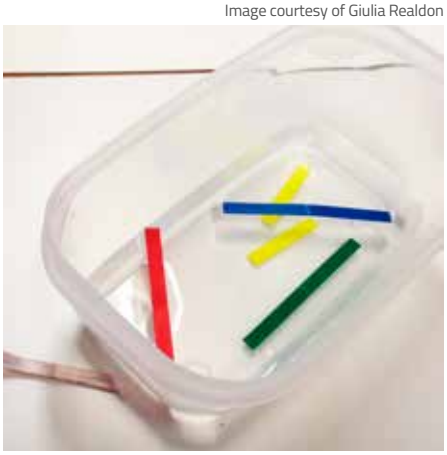
For each student group (or in the case of younger children, for the whole class):

- Bag of common plastic household objects (e.g. bottles, cups, trays, cutlery, boxes, bags)
- Two sets of plastic strips, each consisting of strips of polypropylene (PP), polyvinylchloride (PVC), high density polyethylene (HDPE) and polystyrene (PS), marked with their name using a permanent marker. The strips can be cut from household objects (bottles, cups, trays and other containers); you will normally find the composition of each object on its label.
- Four glass beakers or small jars with lids (100 ml) marked with the names of the plastics (PP, PVC, HDPEand PS)

Image courtesy of Giulia Realdon



Investigating the effect of heat on different plastics



Investigating the buoyancy of different plastics

- Worksheet created by the teacher, listing the name, abbreviation and recycling symbol of the four different plastics
- One 500 ml rectangular plastic tub
- One spoon
- Tap water
- Salt
- Absorbent kitchen paper (paper towels)

Procedure

The uses of different plastics

Ask the students to take the bag of plastic objects, and for each item:

- Identify its use.
- Find the abbreviation/symbol of the plastic type (this should be marked on the object).
- Match this to the information on the worksheet to identify the type of plastic.

Then ask the students to discuss what types of object each plastic is used to make. For example, yoghurt pots are normally made from from PVC, carrier bags from HDPE and food boxes from PP.

The characteristics of different plastics

Give each group of students two sets of plastic strips, and ask them to carry out the following investigations.

Safety note: The first experiment should be carried out in a fume cupboard or, if this is not possible, close to an open window. See also the general safety note on the *Science in School* website.

1. Action of acetone. This takes at least 30 minutes, so begin with this test.

Image courtesy of Marta Cucut

Small fish 'eating' microplastics.

Take the first set of plastic strips and put each strip into a separate beaker. Half fill the beakers with acetone and put the lids on. At the end of the activity, observe which plastics have been affected by acetone. (Only PS will be affected, becoming softer.)

2. Density. Put the four strips into the plastic tub half-filled with the diluted alcohol solution (less dense than water). Press them down and observe if they float or sink. Then empty the tub, wipe the strips, and half fill the tub with tap water. Again, see if the four strips float or sink. Finally, add a spoonful of salt to the water, stir until it dissolves, and again test if the four strips float or sink.

   The students will see that the plastics have different densities; some are denser than water and some less dense. PP has a density of 0.90 g/cm^3, HDPE of 0.95 g/cm^3, PS of 1.04 g/cm^3 and PVC of 1.40 g/cm^3.
3. Action of heat. Insert the four strips into the polystyrene block so that they stay vertical. Aim the jet of the hairdryer at the strips (the teacher should carry out this step for younger students) and observe if they bend or not.
4. Flexibility and fold colour. Take each plastic strip and fold it forwards and backwards to observe its flexibility. Then fold the strip over completely, pressing it down, and observe the colour of the fold (unchanged or white).

After the experiment, discuss the students' observations. Ask the students which type of plastic would be most suitable for the following uses, and why?

- Acetone bottles
- Sea buoys
- Lake buoys
- Coffee cups
- Objects that are repeatedly bent, e.g. shampoo bottles with flip-up lids

Microplastics on the seashore

In this activity, students aged 11–16 investigate the microplastic pollutants in a sample of sand from a local seashore, lakeside or river bank.

Image courtesy of Marta Cucut

Anyone for a plate of fish (and plastic)?

Materials

- A sample of sand polluted with plastic and other waste. (Nearly every European sandy beach contains microplastics, along with plastic fragments of different sizes.)
- Magnifying lenses

Procedure

1. Ask the students to observe the sand samples with the naked eye and with the magnifying lens. Can they see any plastic fragments?
2. Discuss where the students think the fragments come from.
3. Watch some videos about plastics in the environment[w4].
4. Discuss with the students the hazards of microplastics and the importance of preventing marine pollution by separately collecting, recycling and re-using plastic objects.

Microbeads from cosmetics

Microbeads are another source of microplastics. These tiny plastic beads are used in cosmetics and personal care products (e.g. exfoliating and hand-washing creams, toothpastes). In this activity, students (aged 11–16) isolate and examine microbeads from such products, and consider their impact on the environment.

Image courtesy of Giulia Realdon

Cosmetics and personal care products often contain microplastics

Materials

- Some cosmetics and personal care products containing microbeads. Check the composition: if polyethylene is listed, the product contains microbeads.
- Clear acetate sheets
- Magnifying glasses or a microscope
- Transparent plastic cups
- Tap water
- Dishwashing detergent
- Salt
- Spoon

Procedure

Using the materials above, ask the students to:

1. Read the composition of the product to confirm that it contains microbeads.
2. Examine the product by spreading it on an acetate sheet and looking at it with the magnifying lens (or a microscope), and also by touching it.
3. Test the microbeads for buoyancy in three different liquids, using the transparent cups:
   - Tap water
   - Water plus detergent (1/2 spoonful per cup)
   - Water plus salt (1 spoonful per cup).
4. Based on the students' results, predict whether in the natural environment, microbeads will float or sink in freshwater (e.g. in a lake) and in saltwater (e.g. in the sea).

How many microbeads are we dumping in the sea?

This extension to the previous activity asks students aged 11–16 to make a rough estimate of how many microbeads are being dumped each year by people in their town, and to investigate and debate the environmental issues involved.

Materials

- As for the previous activity, plus:
- Measuring spoons with a volume of 5 ml (like those used for cough syrups, etc.)
- Coffee filters

Procedure

Ask the students to:

1. Measure 5 ml of a product containing microbeads and dissolve it in a cup half-filled with tap water plus 5 ml of dishwashing detergent.
2. Stir the mixture for one minute, then filter the mixture with a coffee filter.
3. Transfer the microbeads from the filter paper to an acetate sheet. Now count the microbeads.
4. Using this result and the volume of the product's original container, calculate how many microbeads are contained in a whole tube or bottle.
5. Estimate how many containers of this product are used by a person in one year, and how many people in their town are likely to use this product.
6. Multiply these numbers together to calculate how many microbeads their town is dumping into the sewage system (and then into the sea) per year from this one product.

Finally, ask the students to research information about the problem of microbeads in the environment, and on current debates and actions limiting or banning their use in products[w5].

Acknowledgements

The activities described in this article were developed jointly by the author, Giuliana Candussio, Marinella Manià and Serenella Palamin. All four are members of *Scienza under 18 Isontina*[w2], an association that aims to inspire school students and teachers and to share good practice.

The 'Exploring plastics' activity was adapted from materials developed as part of *progetto APQUA*, the Italian version of the Lawrence Hall of Science, University of California at Berkeley's Science Education for Public Understanding Program (SEPUP). The *progetto APQUA* materials were kindly provided by Federchimica-Assoplast, the association of Italian plastic manufacturers.

Web references

w1 The author, Giulia Realdon, recorded her experiences as a 'Teacher at sea' in a blog. See: www.tasprepared.blogspot.com

w2 To learn more about the *Scienza under 18 Isontina*, visit the association's website (in Italian). See: www.scienzaunder18isontina.it

w3 Full details of the drama activity about fishing can be downloaded from the *Science in School* website. See: www.scienceinschool.org/2015/issue34/microplastics

w4 To learn more about plastics in the oceanic environment, see the video 'It's a plastic world' (http://itsaplasticworld.com) and a thought-provoking video about marine litter and plankton (www.youtube.com/watch?v=xzklQprO59g)

w5 To learn more about microbeads in personal care products, see the 5Gyres website: www.5gyres.org/microbeads

w6 To learn more about SEPUP, visit the programme website. See: http://sepuplhs.org/middle/modules/living

Resources

Thompson RC et al (2004) Lost at sea: where is all the plastic? *Science* **304:** 838. doi: 10.1126/science.1094559

Lusher AL, McHugh M, Thompson RC (2013) Occurrence of microplastics in the gastrointestinal tract of pelagic and demersal fish from the English Channel. *Marine Pollution Bulletin* **67(1)**: 94-99. doi: 10.1016/j.marpolbul.2012.11.028

Watch a fun video (in Italian) on what it might be like to live without plastics and other synthetic materials: See: www.sperimentarea.tv/ondemand/vivere-senza-chimica

Further useful information can be found in the abstracts of a 2014 conference entitled 'Fate and impact of microplastics in marine ecosystems'. See: http://micro2014.sciencesconf.org or use the direct link: http://tinyurl.com/microplasticsfate

To find out more about the author, Giulia Realdon, see an interview in this issue of *Science in School*:

Howes L (2015) Teacher on the high seas. *Science in School* **35**: 29-31. www.scienceinschool.org/2015/issue34/realdon

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