The GreenLab_OS - Micro Plastics in our Environment

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Abstract

The topic of micro plastics and their negative effects on the environment increasingly got into the focus of public discourse in the last few years. It is a very important environmental issue by far and even though it has recently been made subject of discussion by politicians, the society and economists alike, it has not yet been addressed in the educational context of schools and science education. The increasing use of plastics in general has led to a high annual amount of plastic waste each year. This however, is not the end of it since lot of said plastic waste finds its way into rivers and seas. While wind, sun and waves interact with parts of macro plastics some smaller parts break apart. If the degradation has reached a certain level these small parts are called micro plastic. Also, the cosmetics industry and washing machines occur to be a source of micro plastics. Marine researches work under tremendous pressure to find out about the effects of micro plastics on the biotic an abiotic environment. To establish this topic as part of the school curriculum, some of the current research subjects were adapted and simplified as school as model experiments. Currently, it is one offering in the mobile student's lab of the University of Osnabrück. This extracurricular lab day is a great offer for high school students in which they perform chemical experiments and discuss biological aspects of sustainability. In this presentation, the experiments of the lab day as well as an implementation of the current research in school will be presented.

Keywords: *Micro plastics, student lab, sustainability;*

1. Introduction

The subject of microplastics and their impact on the environment has not only gained increasing media attention in recent years, but has also become a major field of research around the world. Currently, this topic is being discussed intensively in society, by policymakers, and by science, and thus represents a highly topical issue that has yet to be addressed in the school context. Since it is important for science teaching to take up particularly current topics and find ways to address them with experiments, one innovative model experiment related to microplastics is offered below for use in upper secondary contexts. Current scientific research serves as the foundation and can be made available to the teaching process with the help of this experiments. In the experiment, it is investigated how to use density separation to remove both primary and secondary microplastics from sediment, i.e. already released into the environment. This helps the students make the connection between the direct anthropogenic introduction of primary microplastics to the environment through the use of certain cosmetics products and the difficulties of removing the microplastics once introduced into the environment. The experiments are highly relevant to the everyday life and experiences of teenagers and are low cost for easy and affordable integration into curricula.

2. Sediment analysis

Microplastic contamination of the world's waterways is an increasing problem. Whether secondary or primary microplastics, at some point a large portion of the plastic particles will sink to the bottom of the water and mix with the sediment of the subsoil [1]. At this station, students will experience a model experiment that shows, in a simplified manner, the environmental impact of sediment being contaminated with microplastics. The experiment is based on a density separation process. Due to the different densities of the sediment (quartz sand: approx. 2.6 g/m^3) and plastic (0.8 g Polypropylene - 1.4g Polyvinylchloride), these two materials can be separated using a suitable solution [2]. The content of this experiment is the extraction of microplastics from a solid sample using a self-built density separation apparatus. The aim is to separate the plastic particles from the sediment and then analyze them. The apparatus is *low cost* and made from simple everyday objects [3]. In the end, the

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students should be able to reflect on whether this method can be used for model experiments in scientific praxis.

2.1 Preparing the microplastics

To make the microplastic compound for use in the experiment, well-known everyday objects are cut into rough chunks using pruning shears, then ground using a coffee grinder to a particle size of about 0.5-2 mm. The microplastic particles are then transferred to small snap-cap vials and labeled.

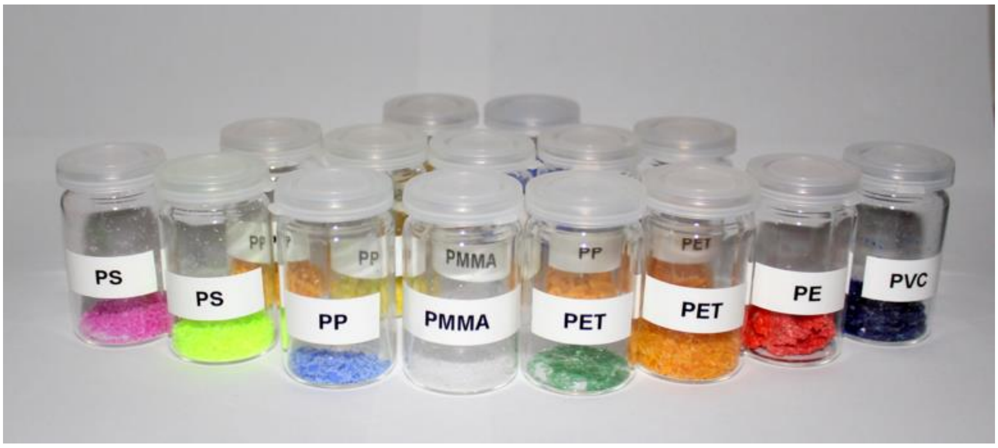

Fig 1. Snap-cap vials with microplastic samples for the sediment analysis model experiment.

In order to identify the types of plastic more accurately, FTIR analysis is recommended [4]. Subsequently, samples of washed aquarium sand are contaminated with 10-20 different microplastic particles. Record the number, color, and type of plastic added. For this purpose, 40 g of sand including the microplastic particles are transferred to the snap-cap vials and numbered. The types of plastic should be clearly distinguishable from one another by color in order to facilitate subsequent analysis of the results [5]. The samples can then be independently analyzed by the students as part of action- and problem-solving oriented instruction [6].

2.2 Preparation of the NaCl-sucrose solution

In order to perform this experiment, a solution with the highest possible density is needed. In research, a NaI solution is frequently used for this purpose [7]. Since this would be unsuitable for students due to the environmentally harmful nature of these chemicals, sodium chloride and sucrose are used instead. The solution is used as follows:

First, a saturated NaCl solution is produced. Sucrose is then added with constant stirring until a density of about 1.38 g/l is reached. To accelerate this process, it is recommended to heat the solution slightly with a hotplate. The chemicals are readily available from ordinary grocery stores. The preparation of the solution takes 20 minutes and should be prepared by the teacher ahead of the experiment.

2.3 Constructing the apparatus

The apparatus can either be set up by the teacher before the student experiments or the students can do it as part of their learning experience.

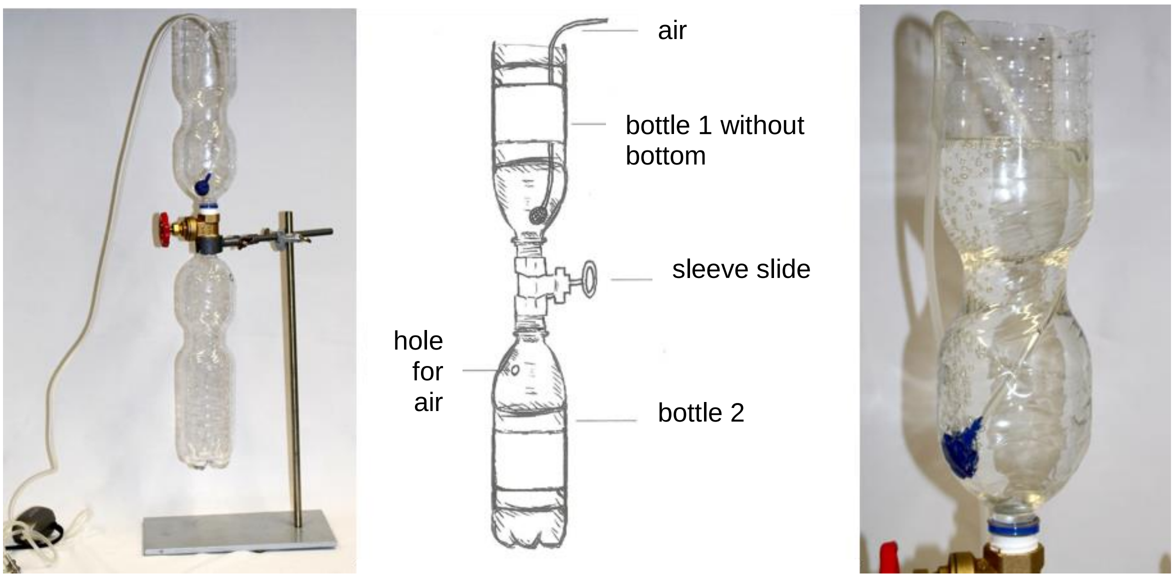

Fig. 2. The apparatus for density separation sediment analysis.

On the left in Fig. 2 is the entire apparatus before being filled with NaCl sucrose solution; on the right is the apparatus after being filled and air is subsequently supplied. The circulation generated by the rising bubbles results in the separation of the sediment sample. The upper bottle (right) is filled with the separating liquid and the sleeve slide is closed beforehand. Then the air supply is turned on, so that fine bubbles rise. The threads of the bottles are wrapped with Teflon tape before the connection with the sleeve value to ensure the tightest seal possible. Once both bottles are connected with the sleeve valve, they are fixed in the middle with the help of the tripod. In the next step, the bottom of the upper bottle is removed with the help of a carpet knife. In the lower bottle, a small hole is cut into the upper edge. This will allow excess air to escape from the lower bottle. After filling the upper bottle with the NaCl sucrose solution, the aquarium pump's air nozzle is attached to the upper bottle using a connecting tube and fixed to the edge with a bit of adhesive tape. The density separation takes place in the upper part of the apparatus by slowly scattering sand into the water circulating through the air column.

The microplastic particles collect in the upper part of the suspension partly on the surface of the solution and partly in the water column. Then, the sleeve valve is gently opened to let the sediment at the bottom slowly settle into the lower bottle. Microplastics and sediment were now visibly separated with the help of the apparatus. The plastic particles are now in the upper bottle, the sediment in the lower bottle.

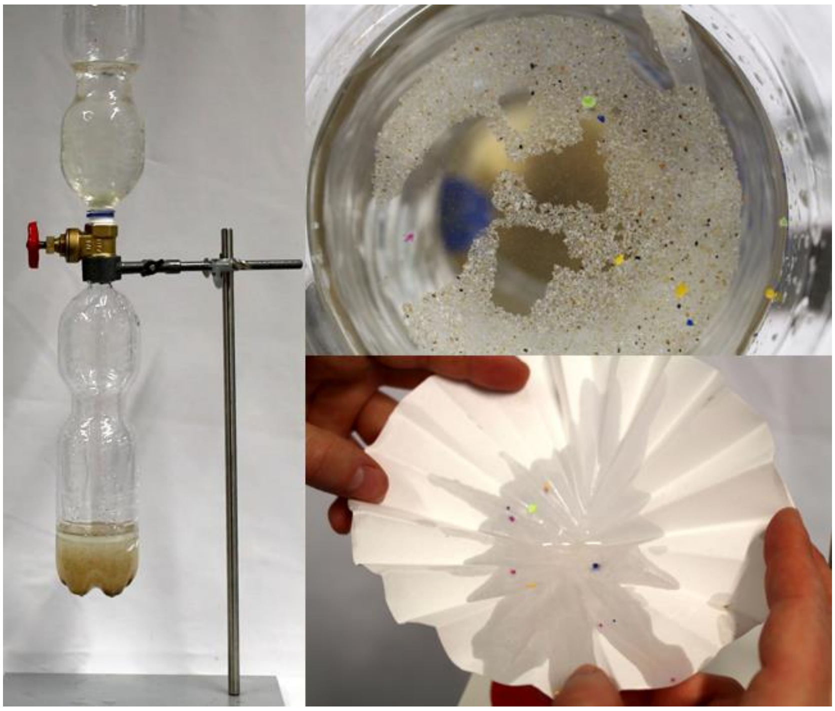

Fig. 3. Apparatus for sediment analysis after separation: in the upper part of the apparatus there is a suspension of microplastic particles and the NaCl-sucrose solution. In the lower part of the apparatus, the excess sediment has been collected.

The upper suspension is then filtered using a pleated filter. Afterwards, the microplastic particles can be sorted by color to determine their origin and their properties. Plan about 30 minutes for the experiment, including filtration.

3. Didactic purpose and conclusion

Since microplastics are an ever-increasing global problem, people must become aware of the impact of these materials on the environment and prevent the waste from entering the waterways in the first place. In order to change society's habits, it is important, therefore, to make people as aware of the problem as possible. For this reason, the integration of this topic into school curricula is more than sensible. These experiments with microplastic contamination helped train the students in making environmental impact assessments. The students were increasingly critical of the microplastic contamination of sediment, especially those who had already discussed the subject of microplastics and their impact on the environment.

By addressing the impact of plastics contaminating the environment through experiments, students can directly experience what would otherwise not be evident in everyday life. In addition to learning how plastics make their way into and are spread through the environment, other concepts must be developed to address this serious environmental problem. Teaching chemistry in context was the focus for this experiment's design [8]. For this reason, it will be important in the future to devise further experiments on a scholarly and school level beyond the experiments described in order to make the topic of microplastics and their impact even more visible to the public and integrate it into everyday school lessons. This design used *low-cost* methods to make science-based experiments more accessible to pupils and their everyday experience and to simplify for teachers the setup and cost for such experiments [3].

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