‘Schools Under the Microscope: children measuring airborne microplastics in the classroom’ Final Report

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Executive summary

Schools Under the Microscope was a citizen science project which extended the learning and development undertaken during the HOMEs Under the Microscope project by applying and adapting methods developed during HOMEs to the school context, to facilitate citizen and child-led research.

Using learnings from HOMEs, the project team developed education resources which were piloted in **one primary school in Bristol** within underrepresented communities/low socioeconomic demographic groups. The project ran July 2023-June 2024 and engaged with:

- 90 Year 6 schoolchildren (aged 10-11)
- three teachers
- five parents.

Teachers co-created resources while children measured airborne microfibres in schools and facilitated intergenerational participation with caregivers. This led to the development and sharing of new knowledge within this emerging field.

Main finding and outcomes:

- It was the first experience of citizen science for all the participants.
- School children and teachers enjoyed the activities and expressed interest in taking part in future citizen science projects.
- Children reported enjoyment at contributing to 'real science'.
- The project helped raise awareness of citizen science and what a scientist is and what they do ('not just potions and making things explode' as stated by one child).
- Overall, the microfibres collection method was successful.
- However, some elements of the method work less well, such as the ability and expectation of children to see fibres under the microscope.

Future citizen science studies in schools should co-create materials and methods with both teachers and children to ensure there is methodological appropriateness and clear expectations of what the experience and outcomes will be.

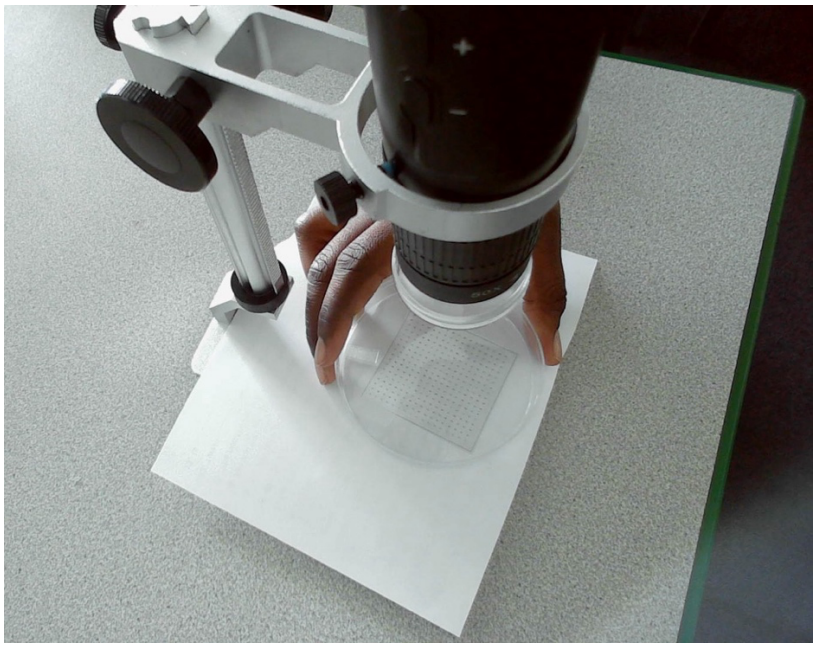
1. Schools Under the Microscope: practical activity

Teachers were sent draft lesson plans and PowerPoint presentations based on the HOMEs project. From this the resources to be used within the Schools project were co-developed. Final resources, including microscopes and pre-prepared sample dishes were dropped off at school and final questions answered by the team.

The teachers implemented the resource over two weeks:

- **Week 1**: introduction to HOMEs and Schools project, including watching a short welcome video made by the team, where the role of children as researchers was highlighted. Other topics included finding out about dust, learning about the method, planning and distributing sample dishes. See Appendix I for details on the lesson's contents.
- **Week 2**: (coincided with Science Week) collection of sample dishes, filling in tables with data, use of branch diagram and microscopes.

Microscopes used during the activity were donated to the school, a further legacy of the Schools Under the Microscope project, with evidence that these microscopes were also used for other science related activities. For example, the school mentioned one of the next topics in Year 6 was Mould, and how the microscopes would be useful to do practical work in that topic.



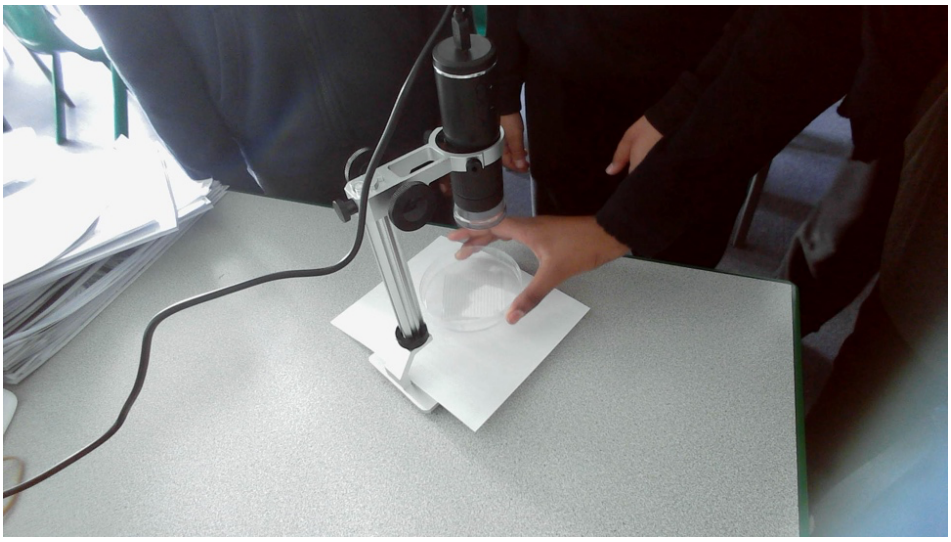


Figure 1 and 2 – Schoolchildren looking at samples.

2. Feedback

We collected feedback on the activity, using focus groups and interviews conducted in the school. In total, feedback was collected via:

- Three focus groups with children (see Appendix II)
- Individual interviews with teachers (see Appendix III)
- One focus group with parents (see Appendix IV)

Ethics Approval was achieved through an application to the UWE Bristol Faculty Research Ethics Committee (REF No: CATE-2324-219). Informed Consent was achieved before taking part in all evaluation activities. All activities in this project have been determined as low risk to the participants and researchers.

3. Findings

The project engaged with three classes of c.30 pupils in year 6 (c.90 in total), three teachers and five parents. Here we report on the findings from the samples collected and photos taken by the schoolchildren, as well as the feedback gathered from schoolchildren, teachers and parents.

3.1 Microfibres

Thirty samples were provided to the school to deploy as required across a two-week sampling period. Samples were returned from five locations within the school. Analysis was done by counting the number fibres within 5 previously randomly selected areas of the sampling grid, for each sample. The same areas were then used consistently across all samples to ensure comparability.

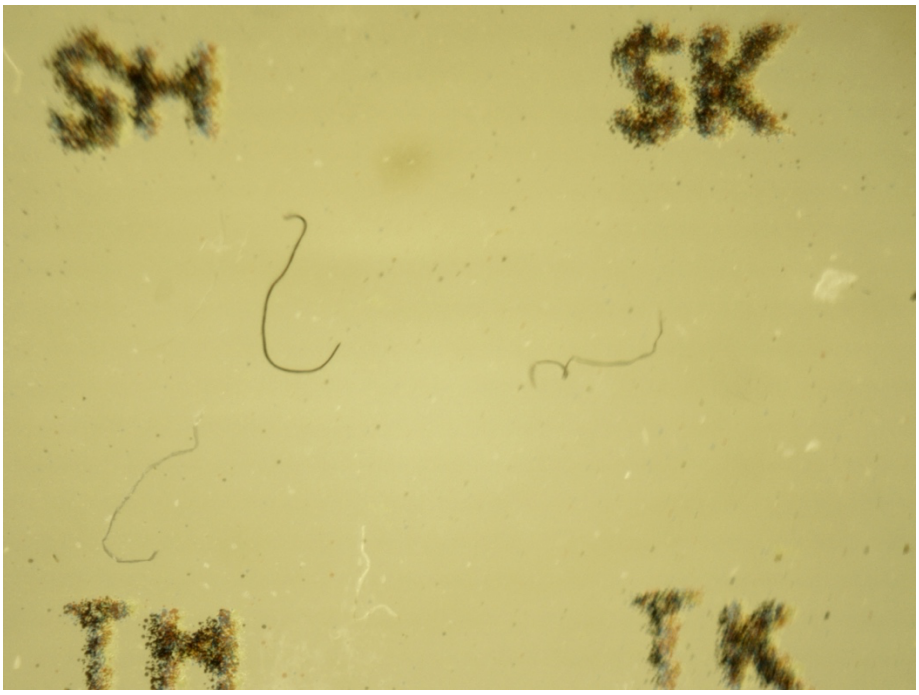


Figure 3 - Sample collected by schoolchildren.

Average deposition rates per mm^2 were then determined for each sample. The deposition rate per location in mm^2, m^2 and m^2 per day (fibres/mm^2/Day) for each sampling location are set out in the Table below.

Sample ID	Fibres per mm^2	Fibres per m^2	Fibres per m^2 per day
Sample 1: Book Corner	0.5	455556	32540
Sample 2: Left set of drawers	0.4	422222	30159
Sample 5: Staff Room	0.4	388889	27778
Sample 8: Library	0.2	244444	17460
Sample 9: ppa room	0.8	800000	57143

Deposited fibres range from 9,524 fibres/mm^2/Day (Sample 10) to 57,143 within the PPA room. Concentrations were consistently higher than found in the main HOMEs study , and higher than those found within indoor environments by (Dris et al., 2017; Jenner et al., 2021; Soltani et al., 2021), but significantly lower than those found by Chen et al. (2023).

Caution should be attributed to the scaling effects of characterising a small area and extrapolating into larger areas. Further caution should be applied when considering these deposition rates, owing to the interactive nature of the sampling, knowledge exchange and analysis process in this study.

3.2 Feedback from teachers

One week after the activity, interviews were conducted with teachers. They reported having a very positive experience and mentioned the school would be open to doing another citizen science project in the future. Schools Under the Microscope was their first ever citizen science project. **Highlights were:**

- Positive connections with the 'working scientifically' demand of the National Curriculum (Department of Education 2013).
- The activity would inform future learning – teachers hope to use microscopes with their work on mould later in the academic year which was made possible through the donation of the equipment.
- Children and teachers all commented on the excitement and commitment children showed towards the project.
- The project demanded a whole school approach to be successful (e.g. needed to make whole school, including cleaning staff who might move sample dishes, aware the project was taking place).
- Resources were used by teachers to positive affect and reported as easy to follow.

Challenges were:

- Children and teachers did not do a final fibre count on sample dishes as planned as they felt numbers were too low to report back and be useful.
- Placing sample dishes in areas of high traffic was problematic and some were moved/destroyed by non-regular cleaners and /or dis-regulated children. Instructions with top tips for placement may be useful in future iterations of resources.
- While the plan was to allow pupils to use microscopes, this activity was teacher led as it was felt that students may break or damage the equipment. Teachers commented that it would be good to have table-based microscopes for children to use and swap round, and then use the electronic ones to send off the data and record. Top tips on using the microscopes should be included in resources.

3.3 Feedback from schoolchildren

Three groups of Year 6 children took part in 30-minute face-to-face focus groups, one week after the activity. In total, 19 children gave feedback (10 boys, 9 girls; 10 participants from Black and other minority heritage).

All children stated they enjoyed the project and felt they were contributing to real science. From their perspective, **highlights were:**

- Everyone would like to do more citizen science projects in school, and a majority of children were keen, having done this in school, to collect data at home using the same method.
- Some pupils learned more about what a scientist is and does “not just potions and making things explode”.
- Discussion of the project with parents was minimal with only one child speaking with parents about what they had done.
- The method was easy to follow for pupils of this age.
- The children used the branching diagram and felt they had been able to identify the fibres.
- Feedback from the UWE team on what was found is expected and maintains engagement with the project.

Challenges identified by children were:

- Children expected to use the microscopes themselves and were disappointed that they didn’t have the opportunity to do this.
- Difficulties in the practical activity included: removal of the sticky strip on the sample dish; needing a piece of white paper underneath the dish to see it on screen when using the microscope because table tops were mottled; having to overcome / work with the glare from the microscopes; finding the microscopes difficult to focus; finding that the microscopes did not magnify to the children’s expectations - children had hoped to see bacteria and virus.
- Many children were disappointed by the lack of fibres that were collected stating they only collected 2 or 3 per dish and thought they would collect a lot more.
- Mental health and wellbeing: after the activity, some children were worried about what they were inhaling and what it might be doing to them. Two children became worried about cleanliness and reported that they were washing their hands, showering etc. more frequently.

3.4 Feedback from parents

One week after the activity in school, one face-to-face focus group took place with five parents. Parents were given a £20 gift voucher as a thank you for their time and contribution. Participants were very appreciative of this, as was the school on behalf of the parents. All parents were interested in the project in school and would like to know more and have access to a report on findings. **Highlights were:**

- While none of the parents had taken part in a citizen science project previously, they would all welcome children bringing resources home to run the HOMES project there. Parents felt doing the project at home would be a good way to support the learning and children would be able to take the lead and teach them.
- No parent could identify any challenges if the children should bring the project home. Everyone was keen to use the microscopes.

- Parents felt that undertaking a citizen science project through school (rather than independently) would give them the incentive to get involved.
- None of the parents identified that a child in their care had increased washing or referred to personal hygiene more since the project.

Minor challenges identified by parents:

- One parent reported that their child had noted the amount of 'dust' at bedtime the previous evening and felt this was unusual. They had seen 'dust' in the light beam and commented that the parent needed to do more cleaning. The parent noted that this type of comment had never occurred previously and were keen to emphasise with the child they could help with the cleaning.
- None of the children had spoken to parents about the project; parents were unsurprised at this as they all reported that little news from a school day was usually communicated.

4. Recommendations

General:

- Consider using school as a springboard / training ground for getting families involved in citizen science projects in future.
- Feedback to pupils / schools with some form of summary is both expected and maintains interest in the project.
- Map the activities onto 'working scientifically' on the curriculum and consider how this intersects with Education Endowment Fund's recent report for any final resource.

For the lesson plans and resources:

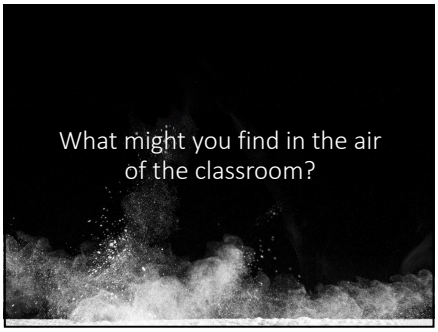
- Include more information about microscopes to avoid disappointment with regard what might / might not be seen at this magnification.
- Explore potential use of different microscopes and how these might be used as a pupil-led activity.
- Explore alternative sticky tapes.
- Provide guidance on top tips for where to put microscopes and who to inform in school in order to support success.
- Provide guidance on wellbeing.
- Have clear request for what data to collect and possible numbers that might be expected. Provide empty tables to assist with this.

5. Conclusions

As set out in this report, this is the first time microfibres have been collected in a school environment and the first time such a sampling approach (i.e. sampling locations, how children will be engaged in the process) has been co-developed with teachers. Methods co-developed and tested by citizens within the HOMEs study were employed in a school environment. Of note and emphasising the specific needs of different groups in participatory research, some elements worked well (e.g. the ease of deployment) whilst others worked less well (e.g. the ability and expectation of children to see fibres under the microscope), despite there, in general, being significant amounts of microfibres present in the samples.

Future citizen science studies in schools should co-create materials and methods with both teachers and children to ensure there's methodological appropriateness and clear expectations of what the experience and outcomes will be. Care should also be taken of the potential impacts of the findings on the wellbeing of children. For example, when exploring the presence of pollutants within a setting, there is a risk, as experienced in this study, of inducing anxieties, similar to those that may be experienced within the climate change discourse.

Appendix I: Slides used in the lesson



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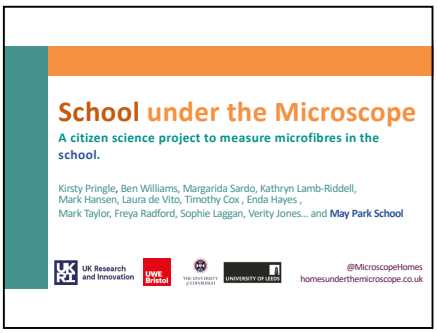

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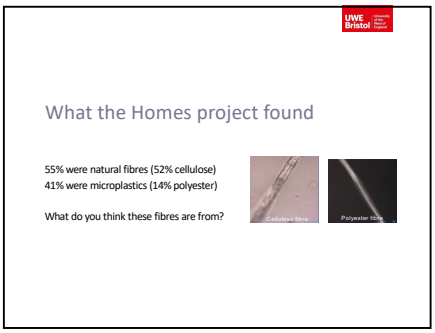

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Why do you think that bedrooms and bathrooms had the highest number of microfibres?

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STEP1: Select the sampling location

- The sample dish should be left **on a flat surface in your main bedroom / sleeping area.** For example, on a bedside cabinet.
- The sampling dish needs to be left open for **2 weeks** so should be placed somewhere it will not be disturbed or knocked over.
- Take care not to leave dishes somewhere they could get hot or block appliance ventilation (e.g. on top of radiators) which could lead to appliance overheating or cause the dish to catch fire.

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STEP2: Prepare the sample dish

1. Remove the dish from the plastic bag.
2. **Fill out the label** with your:
   ID number (school name),
   The sample site (e.g. Year 6 classroom, Dinner Hall),
   Description (e.g. on shelf, on windowsill),
   Date the dish was opened.

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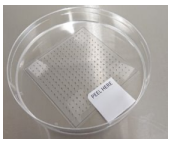
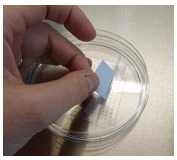
3. Place lid underneath the sample dish. This is to prevent dust and microfibres landing on the lid during sampling, and also to keep the lid with the sample.





4. Remove the protective layer to expose the sticky side of the forensic tape (gently pull upwards and back using the "peel here" label), take care not to touch the sticky tape.

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STEP 4: Leave the sample dish undisturbed for 2 weeks

1.Leave the sample dish as undisturbed as possible for **2 weeks**, during this time fibres and particles, including airborne microplastics, will settle and stick to the sticky layer.

2.After two weeks please replace the lid on the sample dish until you are ready to look at it with the microscope.

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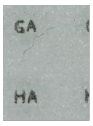
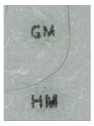
STEP 5: Use your smartphone microscope to take an image of the sample

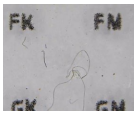
1. Use your microscope to look for fibres on the sample dish.

2. **Take an image with the clearest focus you can get**. The letters on the tape are location markers, please include at least one location marker the **right way up** in your image so that the research team can analyse your image.

3. **Email your images** to: microscopehomes@uwe.ac.uk







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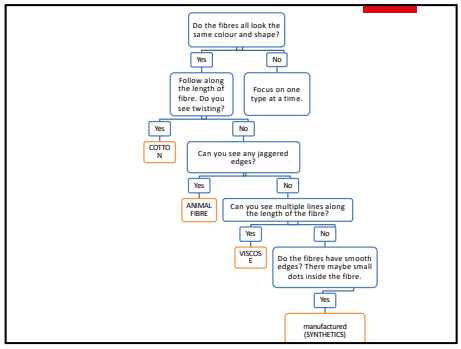

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Many thanks for your help with this study!

This project has received funding from the Biotechnology and Biological Sciences Research Council through the UK Research and Innovation (UKRI) Citizen Science Collaboration Grant. Reference BB/V012584/1

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Possible classroom activities

Instruction writing
Creating graphs of how many fibres in each room for comparison
Art work of microbes by David Goodsell and micro-sculptures by Willard Wigan
Poetry inspired by microscopes e.g. Counting Sheep or A handful of Dust or Wallace Steven's Thirteen Ways of Looking at a Blackbird.

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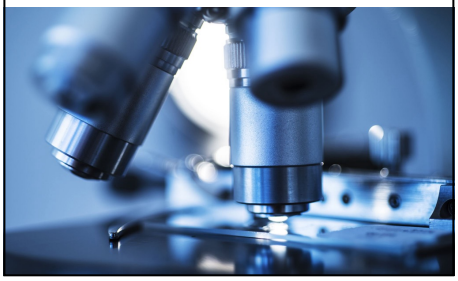
Microscopes:



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Who invented microscopes and what do they do?

Watch Scales of the Universe clip (9mins) to explore what can be seen by powerful telescopes and microscopes Scales of the Universe in Powers of Ten - Full HD 1080p (youtube.com) (or just microscope from 6 min 10 sec)

Watch BBC Bitesized Microscopy to see different sorts of microscopes BBC Two - Bitesize Science - Microscopy

History of who invented microscopes (lots of dead white men) The History of the Microscope (youtube.com) 3 mins

NOTE: Dr Bullar (1863 president of Southampton Microscopical Soc) commented that microscopy 'was a branch of science they may both delight and excel in, for it deals with the most delicate objects, requiring the finest touch and handling, all of which display exquisite workmanship and many consummate beauty'*. Women were commonly involved in generating accurate drawings from objects observed under the microscope (while perhaps only their husbands or fathers, as in the case of the Lister sisters may have been credited)

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Dr Katherine Esau

(1898-1997) plant anatomy and microscopy

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Susanna and Anne Lister: scientific illustrators of 1600/1700's

Anne & Susanna Lister — Museum of the Earth

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Examples of Black British Scientists that use microscopes

Dr Donald Palmer 1962–

Donald is an Associate Professor of Immunology. His research involves investigating the way the human body changes with age, as well as the identification of 'markers' on the surfaces of cells. Through this research, he is able to learn about how the body protects itself from diseases such as cancer and infections.

Donald carried out post-doctoral work at Cancer Research UK and Imperial College, London. Donald is also a co-founder of Reach Society. The aim of this society is to encourage and inspire young people, especially black boys and young black men to realise their potential

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Dame Elizabeth Anionwu 1947–

Elizabeth began working in the NHS at the age of 16. She helped to set up the first nurse-led sickle cell and thalassaemia screening and counselling centre. This pioneering service led to the nationwide screening of babies. Elizabeth has worked tirelessly throughout her career to ensure that people with sickle cell disease and thalassaemia get all the support they need and deserve.

Through her work and research, Elizabeth has made a large contribution to the health and wellbeing of multi-ethnic communities. Elizabeth overcame stigma and racism to build a distinguished career as a nurse, health visitor, academic and campaigner.

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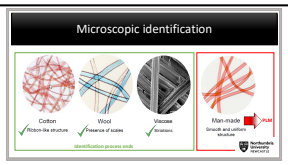

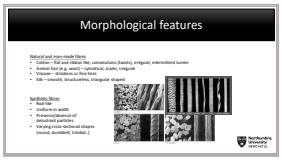

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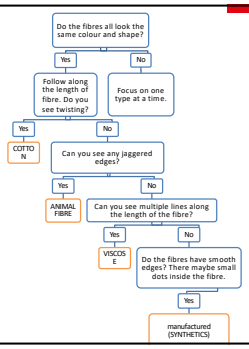

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Poetry inspiration: Wallace Stevens, Someone Puts a Pineapple Together: explores seeing things differently (can be linked to what we might see through a microscope)

Someone Puts a Pineapple Together
By Wallace Stevens

The hut stands by itself beneath the palms.
Out of their bottle the green genii come.
A vine has climbed the other side of the wall.

The sea is spouting upward out of rocks.
The symbol of feasts and of oblivion.
White sky, pink, sun, trees on a distant peak.

The lozenges are nailed-up lattices.
The owl sits humped. It has a hundred eyes.
The cocoanut and cockerel in one.

This is how yesterday's volcano looks.
There is an island Palahude by name –
An uncivil shape like a gigantic haw.

These casual exfoliations are
Of the tropic of resemblance, sprigs
Of Capricorn or as the sign demands,

Apposites, to the slightest edge, of the whole
Undescribed composition of the sugar-cone,
Shiftings of an inchoate crystal tableau,
The momentary footings of a climb
Up the pineapple. . .

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Appendix II: Focus groups questions (pupils)

- Tell me about the workshops you've been doing at school.
- Were you interested in the project from the start? Why? (did it sound interesting, useful, fun, or boring?!)
- What's your previous experience of science?
- Have you done anything like this before? Where you have collected data for a bigger project outside of school? Is it something you might want to do again?
- What have you found interesting about what you've been doing?
- Is there anything that you haven't understood or has puzzled you?
- What do you think you've learned (skills and knowledge)?
- Have you shared your learning with anyone outside of the classroom – in other classes / at home / outside of school. Can you tell me about those conversations?
- If the investigation were to run again in a different school, what advice would you give? Does there need to be more, or less of something? Do something differently?
- What would you like to do next with regard the project? Would you expect feedback from the scientists? When? How often?
- Do you know more about what it's like to be a scientist? Is this something you might consider in the future?

Appendix III: Interviews with teachers

- Tell me about your involvement with the project.
- Why did you want to be involved?
- Have you had previous experience of a citizen science project (individually or part of the school?)
- Did the project fit with the curriculum? (if so how? Does it matter if it doesn't?)
- How is the project different / similar to usual science in school?
- What were the challenges and barriers to engaging with the project?
- What support was there, how did it help / hinder?
- Was there any language / terms that needed to be unpacked?
- What were the successes?
- Are there any particular instances of children engaging with the project themes at home that you're aware of?
- How might the workshops / resources be improved if they were to be run at other schools? Year groups?
- Will you use any / all of the project in future years / different age / ability groups etc?
- Would you take part in future citizen science projects (individually / as a school).

Appendix IV: Focus groups with parents

- Can you tell me about the science your child learns (at home or school).
- Have you or your family ever been involved in a citizen science project?
- Your child has been involved with a project in school about microfibres – have you heard anything about it? What aspects of it are you aware of.
- Before the project has your child shown any interest about microplastics / microfibres ? (sometimes they may have heard about these in the sea or in relation to litter)
- How have they responded to these themes? How have you responded to their learning?
- Is there anything that would help you support your children in learning about these issues? What might that look like?
- Is there anything that would help you / encourage you to learn more about / engage with citizen science projects?