

DELIVERABLE 5.5

Case Study 2 (UK) – Stage 2



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 872500.



**"ParCos – Participatory Communication of Science"
A HORIZON 2020 RESEARCH AND INNOVATION ACTION**

Consortium: Lappeenrannan-Lahden teknillinen yliopisto (FI, coordinator), Katholieke Universiteit Leuven (BE), Vlaamse Radio- en Televisieomroeporganisatie (BE), and Knowle West Media Centre LBG (UK).

Webpage: <https://parcos-project.eu>

Duration: 1/2020 – 12/2022

Grant: H2020-872500 (Call H2020-SwafS-2019-1)

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DESCRIPTION OF THE DELIVERABLE

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Number of Deliverable	D5.5
Title of Deliverable	Case Study 2 (UK) – Stage 2
License	CC BY 4.0, see https://creativecommons.org/licenses/by/4.0/
Attribution	CC BY 4.0 ParCos, http://parcos-project.eu H2020-872500
Dissemination Level	PU
Contractual delivery date	2020-06-30
To be cited as	Evans, P., Grimes, A., Sweeney, L., Hudson L. and Dowling, F. Quick, M. (2022). Case Study 2 (UK) – Stage 2, deliverable 5.5 of the Horizon 2020 project ParCos, EC grant agreement no 872500, Lappeenranta, Finland.

SUMMARY

Deliverable 5.5 - Case Study 2 (UK) Stage 2 – provides an overview of the outputs of the UK case study in the ParCos project, which is led by Knowle West Media Centre in Bristol. It is the output of Task 5.5 in Work Package 5 (WP5) – Case Studies and Communications. This report contains an introduction to ParCos, describes the purpose and role of this deliverable, describes the outputs of stage 2 of the UK case study and the key learning for ParCos. This report builds upon the Deliverable 5.2 report which was published in April 2021 (Month 16) of the project.

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1 INTRODUCTION

Deliverable 5.5. (D5.5) provides an overview of the outputs of Stage 2 of Case Study 2 in the ParCos project, which is led by Knowle West Media Centre in Bristol, UK. It is the output of Task 5.2 in Work Package 5 (WP5) – Case Studies and Communications. This report contains

an introduction to ParCos, describes the purpose and role of this deliverable and then describes the outputs of stage 2 of the UK case study and the key learning for ParCos. This report builds upon the Deliverable 5.2 report which was published in April 2021 (Month 16) of the project (Hudson et al., 2021). That report describes Stage 1 of the case study including the ReThink ReMake Recycle activities.

1.1 THE PARCOS PROJECT

Participatory science and engaging activities are key to ensuring science communication increases public engagement in science. This can be achieved through collaborations between scientists and the non-scientist public. However, concerns about public science literacy are on the rise. The EU-funded PARCOS project will work to create participatory science stories that link to source material that the public can interpret for themselves. The project will explore ways to ensure diversity and inclusion in science participation and communication. It will also discuss the creation of engaging stories for the public that include the public in science activities and the interpretation of the outcomes. By disseminating stories alongside evidence, the audience will be invited to tell their own stories using the ParCos tools.

1.2 PURPOSE AND ROLE OF THIS DELIVERABLE

This deliverable sits within WP5 ‘Case Studies and Communications’ which is being conducted over a 28-month period (June 2020 to October 2022). There are 3 case studies within the ParCos project in three different countries – Belgium, Finland and the UK. The purpose of Task 5.2. within WP5 is to implement and evaluate Case Study 2, which is the UK case study, which is reported on in D5.2.

There are 2 stages to the ParCos case studies:

- Stage 1: focuses on the methods of conducting science and collecting data that are relevant to the framing of the case study and to their local context. Each case study will use an appropriate scientific method for collecting data, either predetermined within the case study description or selected by the case study participants in the early stages.
- Stage 2: the case study participants receive training (prepared in WP4) for creating participatory science stories and participate within a participatory design process to create participatory science stories and to integrate methods for communicating these stories to their wider communities and the general public.

Common activities that are being conducted in the context of the three ParCos case studies are:

- a) Identifying and/or collecting data for science stories
- b) Exploring data using ParCos tools

- c) Creating and communicating participatory science stories designed to prompt further engagement by the public

D5.2 was published in month 16 (April 2021) and focused on the implementation of Stage 1 of the UK case study. This updated version (D5.5) integrates Stage 2 of the UK case study and the evaluation. It will be published on the ParCos Platform and The Bristol Approach website <https://www.bristolapproach.org/bristol-approach/>.

1.3 OVERVIEW OF THE PARCOS CASE STUDIES

1.3.1 Goal

The goal of ParCos is ‘To improve science communication with the public by creating participatory science stories that link to source evidence that the public can interpret for themselves and then build new science activities on top of this using popular forms of broadcast media and VR/AR technologies. As shown on Figure 1, ParCos is developing participatory design models, methods and tools which are being tested within three case studies in Belgium, Finland and the UK. Each case study has a different focus, in terms of the science topics and the group of participants it is working with, but the learning is then brought together and feeds into the creation of the ParCos models, methods and tools.

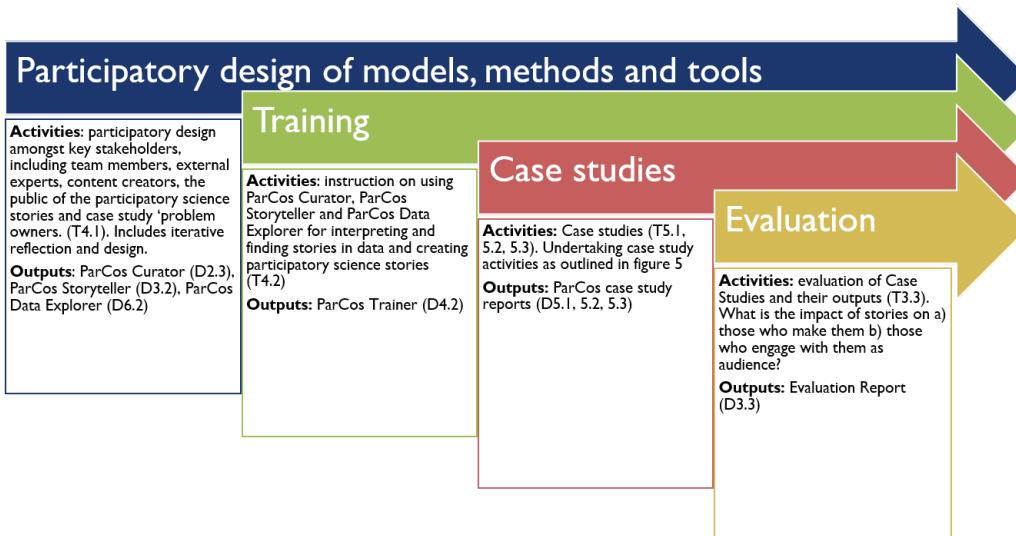


Figure 1: Overview of the ParCos Methodology

Each case study will focus on a different set of stakeholders, who are using data as evidence and who want to tell a story with the data to reach a wider audience. ParCos understands that data is experienced in subjective ways. The case studies will explore participatory approaches to data analysis and the use of arts-based methods to build empathy to data and support discussions about conflicting ideas or interpretations of data.

A brief summary of the three case studies is provided below:

- **Case Study 1:** design explorations based on weather or astronomical data to guide innovative storytelling in broadcasting (Belgium)
- **Case Study 2:** local communities, collecting and using data to address issues of importance to them, and communicating findings in personalised, intelligent and accessible ways including using immersive technologies (UK)
- **Case Study 3:** science in schools, looking at how schoolchildren can use the research data generated by universities and contextualise it to their own context and use through and share with others through documentaries (Finland)

At the heart of the ParCos project is the development of the participatory design methodology - The Bristol Approach to Citizen Science and the use of arts-based methods. Each of the ParCos case studies are using and testing elements of The Bristol Approach as a methodological framework to guide their citizen science communication activities. There is a particular focus on empowering citizens in communicating the outcome of citizen-led science initiatives, drawing upon the work within WP3 (Finding and telling stories from science data, the ParCos Storyteller), which is using arts-based methods for participatory sense making of science data, and WP6 (ParCos Platform).

2 UK CASE STUDY

2.1 GOAL

The goal of the UK (KWMC) case study is work with a local community (Knowle West, Bristol) to explore issues of citizen empowerment in conducting and communicating science by collecting and using data to address issues of importance to them.

Within the UK Case Study local residents are the citizen scientists and they are collaborating with other stakeholders (e.g. scientists, artists, local government) on science communication activities. The learning is being used to inform and develop The Bristol Approach for Citizen Science, which has a focus on understanding how a people and issue led approach supports finding and telling stories in data and how this may lead to differences in the types of stories diverse communities want to tell from data. At the heart of The Bristol Approach is the City Commons, where resources, tools, expertise and technologies are shared and used for common good.

2.1.1 ParCos objectives

The main objective of the ParCos project which was outlined in the project bid is ‘to improve science communication with the public by creating participatory science stories that link to source evidence that the public can interpret for themselves and then build new science activities on top of this using popular forms of broadcast media and VR/AR technologies’. This has 3 underlying objectives shown in Table 1 which we have then translated into aims and objectives for the UK case study.

Table 1: UK Case Study aims and objectives and alignment to wider ParCos objectives

ParCos Objective	UK Case Study Aim	UK Case Study Objective	How objective was met
Objective 2: To improve interaction between different science stakeholders through participatory approaches to science communication	1) To increase Bristol resident's engagement with science through participation in science communication activities with other stakeholders	(a) To recruit > 30 Participants (particular focus Knowle West residents) to take part in ParCos Case Study (b) To run participatory science communication activities with the >30 participants in the ParCos Case Study (c) To work with Case Study participants to create at least 3 Participatory Science Stories	Local residents involved in participatory science activities <ul style="list-style-type: none"> ➤ ReThink ReMake ReCycle - 48 participants ➤ Factory Takeover – 22 participants + 7 volunteers from Knowle West / South Bristol ➤ Slow the Smoke – (sonification and minecraft+final showcase event+citizen scientists) 57 adults, (including young people) 16 children Participatory science stories – RRR Zine,
Objective 3: To develop pedagogical approaches and to deliver teaching of new practices for communicating science to both professional and non-professional users	2) (i) To train Bristol residents in participatory science communication methods and tools developed in ParCos (ii) Disseminate learning about ParCos to wider Bristol stakeholders	(a) To run face to face training on science communication methods with at least 50 members of the public (b) To hold a Showcase Event which shares learning from the Case Study within Bristol at an event with at least 100 visitors (c) To share learning from ParCos Case Study with > 100 people	Members of the public receiving face to face training on science communication: <ul style="list-style-type: none"> ➤ Factory Takeover – 29 participants ➤ Slow the Smoke – 10 participants Showcase event in Bristol – 16 adults Share learning from RRR ParCos case study <ul style="list-style-type: none"> ➤ ENoLL conference presentation 30 ➤ Australian living lab presentation 15



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Objective 1: To increase trust in science outputs through making underlying evidence and its interpretation more transparent	3) To increase Bristol residents' confidence in science communication through the creation of participatory science stories	(a) To support Bristol residents to create at least 17 science stories that reuse material from Participatory Science Stories created in the project	Slow the Smoke technology activity – 13 participants
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2.2 WHO IS INVOLVED?

The location of the UK case study is in Bristol with a particular focus on working with residents and people who work in the neighbourhood of Knowle West. Knowle West is in the Filwood ward of the City of Bristol and in 2019 the population was 13,900 according to the Statistical Ward Profile published by Bristol City Council (2020) and there are around 5500 households. The area has lots of families, as the typical housing stock is 3 bed homes. According to the ward profile it has a significantly higher proportion of young people aged 0-15 years. They make up 25.1% of the population compared to 18.5% on average in Bristol. Therefore, the UK case study has a focus on working with local families.

Filwood is in the top ten indices of deprivation for England and has high levels of child poverty (Bristol City Council, 2020). 44.8% of the community are disadvantaged in terms of Education in Filwood, which is significantly worse than the Bristol average of 27.8% (Bristol City Council, 2020).

The case study in the Ashley ward paid attention to involving people representative of the Ashley ward through many different engagement approaches and with specific communities. According to the Statistical Ward Profile for September 2022 the Ashley Ward has a total of 33.5% of residents from Black, Asian or other Minority Ethnic groups. The statistics also show 23.8% of the residents were born outside of the UK.

Most citizens who participate in citizen science are well educated (Haklay, 2018) and finding ways of engaging less educated or less privileged participants is an important goal if citizen science genuinely wants to move towards involving everybody.

Therefore, the UK case studies has a particular focus on working with people who are typically underrepresented in citizen science.

2.3 METHODS AND TOOLS

At the heart of ParCos project is empowering citizens for participation in research and innovation using participatory citizen science. The UK Case Study is guided by the Bristol Approach – which is a methodology with six steps, as shown on Figure 3, and is being updated as Framework for Citizen Science in the ParCos project. The starting point for The Bristol Approach is the belief that citizens should have a leading role in imaging, designing and building their future.



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Figure 2: The Bristol Approach – The 6 Step Framework

Stage 1 of the UK case study focused on activities guided by Steps 1, 2 and 3 of The Bristol Approach and the learning fed into development of The Bristol Approach for Citizen Science. Whilst Stage 2 focuses more on steps 3-6, although there is inevitably some overlap between all the stages.

We have used arts-based methods within the UK Case Study and the learning has fed into the Guidebook on the use of arts-based methods (ParCos Deliverable 3.1). In particular we undertook creative workshops with families and individuals, working in a consistent and open collaborative style with a wide-ranging group of people who are typically underrepresented in citizen science. We used arts-based methods for creative problem solving, ideation and prototyping, for sense making of the data collected and for telling stories with the data.

The resources, tools and learning developed during the ParCos project have fed into case studies of 'The Bristol Approach to Citizen Science' in action. They are shared on the ParCos project website and also an updated version (launch Dec 22) of The Bristol Approach website (www.bristolapproach.org). Wider ways to exploit the outputs are identified in the ParCos Exploitation Plan (Deliverable 7.4 led by VRT).

The learning from the UK case study and the formalisation of the knowledge is feeding into the development of Principles for Diversity and Inclusion (Deliverable 2.2. led by KWMC and published in December 2022). As part of the UK case study activities, we have collected

equalities data so we are able to understand who participates within the activities and we will use this information to report against the project objectives. We also evaluated people’s experiences of participating in the activities, capturing personal and community narratives. ParCos recognises that it is important to understand who holds the power in undertaking and communicating science, how this power can be given to the hands of the public and how better practices for sharing scientific data can be developed.

Learning from Stage 1 of the UK case study was fed into the development of the science communication tools created in ParCos such as the Data Curator, Data Explorer and Storyteller. In Stage 2, KWMC facilitated a workshop in May 2021 to enable further sharing of the case studies across the partner organisations in ParCos and to explore how that informed the tools developed in ParCos.

3 STAGE 2 OF THE UK CASE STUDY

The aim for Stage 2 of the UK ParCos case study was to focus on the following steps of The Bristol Approach:

- ★ **Step 3 – Designing:** tools and resources, to better understand and address the issue
- ★ **Step 4 - Testing :**what you've designed in a “real world” environment.
- ★ **Step 5 - Sharing:** what was created and learned; celebrating what you've achieved.
- ★ **Step 6 - Reflecting :** on if and how you reached your goals, and what you might focus on next time

The Stage 2 activities have built upon the learning from the ReThink ReMake ReCycle activities in Stage 1. They have also fed into the development of The Bristol Approach for Citizen Science (the report for Deliverable 2.4 (published in Dec 2022). The activities and their development took place between May 2021 and October 2022.

We continued to engage with our existing RRR participants, as well as engaging with more people from the local community (Knowle West in South Bristol) as well as communities in the Ashley ward, east Bristol.

We have focussed on 2 key projects:

- The Factory Takeover: a family friendly workshop at KWMC: The Factory on reusing waste materials, biomaterials. Researching and prototyping engaging and interactive ways to collect, visualise and communicate local data surrounding household waste, recycling and repurposing.
- Slow the Smoke: Training, creating different participatory science stories allowing participants to engage with air quality data collected and create their own participatory science stories. This included experimenting with telling data stories through sound as part of a data sonic animation and gamifying data in Minecraft.

We organised a Bristol showcase event to share learning from the case studies with interested stakeholders in Autumn 2022 as well sharing learning more widely through other dissemination activities including presentations at events such as the European Network of Living Lab (ENoLL) Digital Living Labs Days.

4 THE FACTORY TAKEOVER

The Factory Takeover event was originally scheduled to take place in August 2021 but it had to be delayed to October 2021 due to covid levels still being high in South Bristol in August and the KWMC team had concerns about holding an in-person event and whether we would get a good attendance. Hence the Factory Takeover event was rescheduled to October schools half term and took place at KWMC: The Factory on Thursday 28th October 2021 from 10:00-13:00. The Factory is KWMC's community led maker and innovation space.

The Factory Takeover was a family friendly event on community led science and science communication. A collaboration between The Factory and Maker City¹, which is a 10-week programme for makers aged 10 – 15 from across Bristol, run by KWMC’s Young People’s Team. The Maker City programme has a focus on experimentation and learning using digital manufacturing technologies, product design processes and social action.

4.1 DATA AND INFORMATION COLLECTED

The Factory Takeover event was advertised via KWMC networks and social media as a family friendly 3-hour workshop, taking place in school half-term. We particularly targeted families living in or near to Knowle West. Interested participants initially completed a booking form (on AirTable) to reserve a place. They then confirmed their place by completing the consent form, which dealt with research ethics issue such, also hosted on AirTable. The 2nd form was also a mechanism to collect information about any additional needs of the participants.

10 households signed up to participate in the Factory Takeover event of which 6 were able to participate on the day. Many of the dropouts were due to the result of covid restrictions at the time. The 6 families who took part was 22 people in total – 7 adults and 15 children (aged between 5 and 18). All the families were from South Bristol, 5 from BS4 (which is the postcode Knowle West is located in) and 1 from BS3. The event also involved 7 maker city volunteers who were aged between 10-16 years old who were involved in training the other participants.

4.2 CONTENT PRODUCED

The Factory Takeover involved local families exploring and learning about sustainability through interactive demonstrations and activities. This included science through hands-on making, exploration and play. Using interactive ways to collect, explore, visualise and communicate local data. The arts-based methods involved were digital making and creative experimentation with materials.

The workshop sessions and wider activities which took place were:

- 1) **Experimenting with bio-materials:** in this workshop session participants were supported to experiment with biomaterials and create their own bio-plastic pine resin pot. They followed a recipe and mixed pine resin with different food waste and biodegradable items (e.g. coffee grounds, jute fibres, egg shells, beetroot powder, vegetable peelings) and put the mixture into different moulds to create their pots. This is illustrated in Figures 4 and Figure 5.
- 2) **Making protest placards:** in this workshop session the participants explored environmental sustainability issues, including biodiversity and how its loss is affecting animals. They designed and prototypes protest placards about issues that concerned them. They then laser cut their placards in cardboard using CorelDraw. Some of placards created are shown in Figure 6.

¹ <https://kwmc.org.uk/projects/maker-city/>

- 3) **Repurposing waste materials with robots:** in this activity the participants used scraps, offcuts and waste materials to build the track that the Spheros would navigate. Spheros² are programmable robot ball designed to inspire creativity and curiosity through coding and play, they are managed through an app. See Figure 7.
- 4) **Exploring sustainability and taking action:** in this activity there were interactive displays where the participants could explore the steps KWMC are taking to reduce the organisation's carbon footprint and wider sustainability initiatives. This included videos and posters on KWMC projects including Julie's Bicycle programme, We Can Make and ReThink ReMake ReCycle. People could complete their own waste audit and using lego visually show what they wasted the most (as shown on Figure 8). There was also a wishing tree where they could make a pledge to take an action to reduce their carbon footprint.



Figure 3: Experimenting with bio-materials activity (Photo credit: Ibolya Feher)

² <https://www.trams.co.uk/education/sphero>



Figure 5: Creating pine resin pots from food waste (Photo credit: Ibolya Feher)

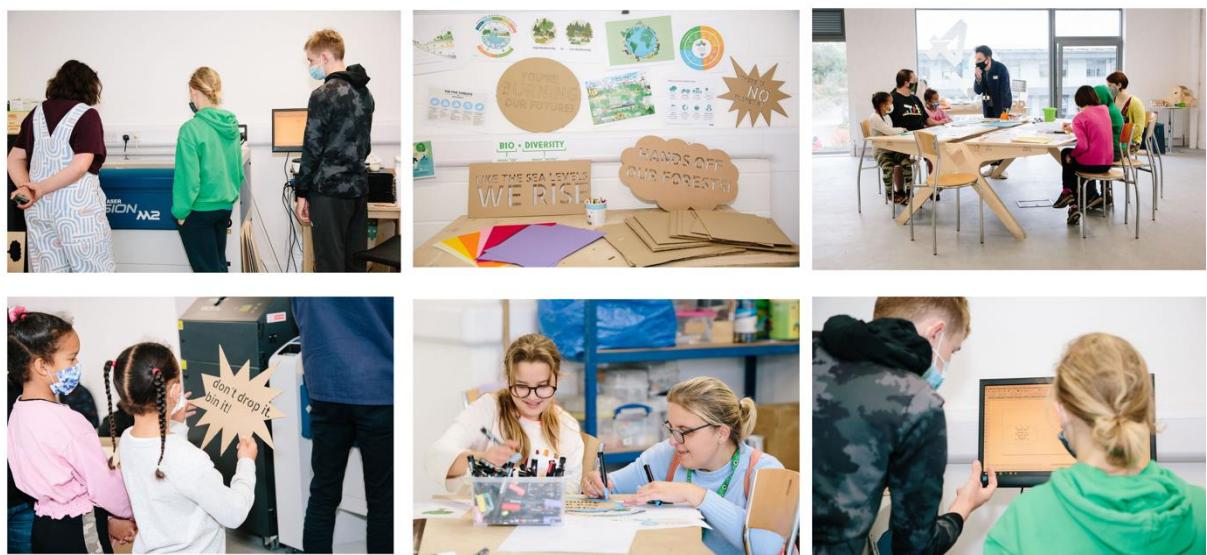


Figure 4: Making laser cut protest placards (Photo credit: Ibolya Feher)



Figure 5: Repurposing waste materials with robots (Photo credit: Ibolya Feher)



Figure 6: Exploring sustainability and taking action

We commissioned a local photographer to take photographs of the event, some of which are shown above. One of the KWMC team captured video content to evaluate the event, which is explained in the next section. We disseminated information about the event on

social media, this included a story on the Factory Instagram account which included photographs and a tweet about the event linked to KWMC's communication on COP26 which included a video compiled from the family videos. This is shown below:

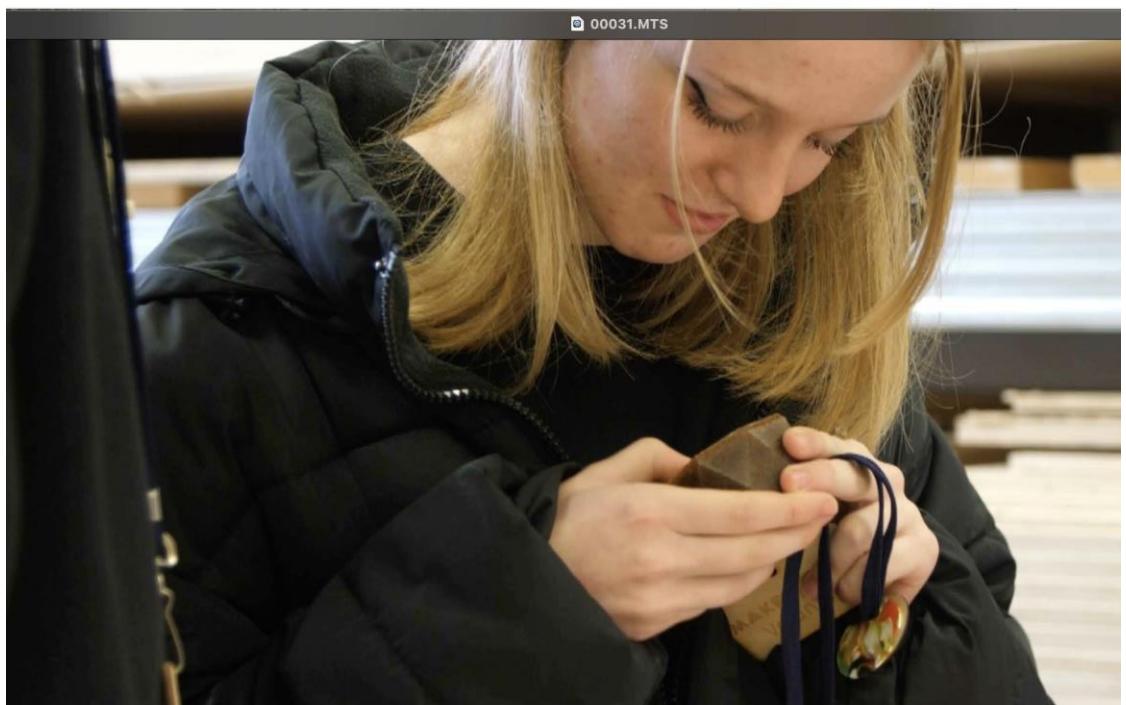


Figure 7: Factory Takeover Video (image capture)

4.3 EVALUATION

At the event we captured videos of the six families with the purpose of collecting feedback on the event as individual narratives. Each family was asked for four questions:

- 1) What did you learn?
- 2) How do you feel about what you have learnt?
- 3) What will you do with what you have learnt?
- 4) What is your pledge?

We also had an evaluation board at the event which the families filled in and is shown in Figure 9.

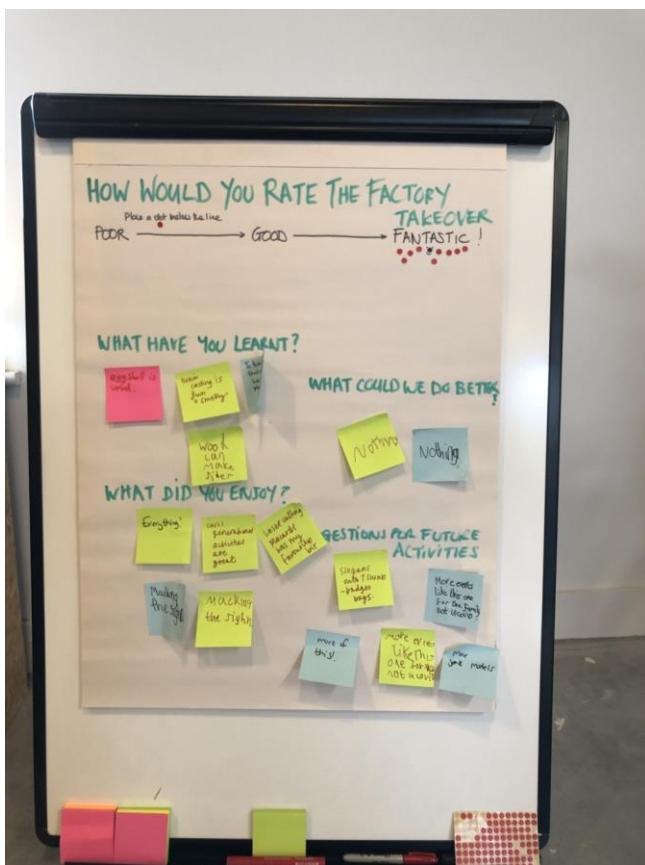


Figure 9: Visual evaluation board at the Factory Takeover

4.4 KEY LEARNING

On 8th December 2021 (9.30-10.30am) the KWMC ParCos team held an online Factory Takeover Debrief Session to reflect on the RRR workshops and activities to date. Figure 11 shows a JamBoard we used to capture the KWMC's teams' thoughts on what had gone well



Figure 10: Factory Takeover: Evaluation session topics

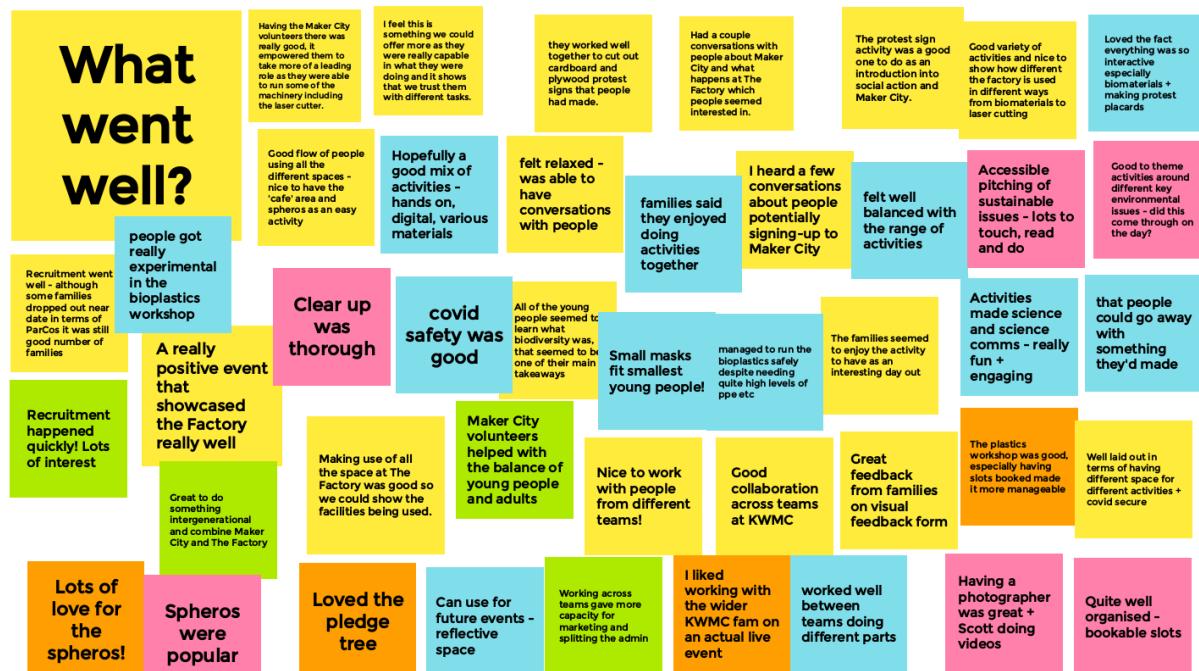


Figure 11: Factory Takeover: What went well?



Figure 12: Factory Takeover: What changes would we make?

Key learning....

- Hyperlocal science communication
- Enabling local people to be part of cutting edge science research
- Lowering barriers to engagement with science
- New experiences through mini experiments and sensory exploration
- Exploring issues and expressing their views through placards & pledges
- Learning through play – new routes into STEM e.g. Spheros and laser cutting
- Taking personal action on issues that matter to them
- Sharing their experiences / learning through videos and visual evaluation

5 INTRODUCTION TO BRISTOL CASE STUDY: SLOW THE SMOKE

5.1 DESCRIPTION OF THE PROJECT

Air Pollution is of high concern in Bristol and the Ashley ward is no exception. An increase in people using wood burners to heat their homes and the effect on health and the environment has motivated this work by trying to get a better understanding of the different sources of particulate pollution. It is data driven and citizen focused.

10 Citizen Scientists have built their own [low cost DIY sensors](#) and have been monitoring air pollution at their homes since November 2021. This indicative data is being analysed and monitored alongside the data from high accuracy sensors in the city by Bristol City Council.

KWMC supported the engagement with citizens in the Ashley Ward, including the citizen scientists through-out the project.



Figure 13. Citizen Scientists building their own low-cost DIY air quality sensors at the workshops in October 2021

Alongside 3 workshops with Citizen Scientists, which included building their own DIY low-cost air quality sensors and a making sense of data workshop; KWMC also hosted 5 workshops within the wider community of the Ashley ward over the duration of 2022.

The workshops with the wider community were planned and co-designed with two of our citizen scientists, both active residents in their communities. During the workshops we gave participants an overview of air pollution, including the sources, impact on health of Nitrogen Dioxide (NO₂) and particulate matter, PM_{2.5} and PM₁₀. We showed them what the air was like in their own neighbourhood, using the data from the DIY air quality sensors and the Bristol Open Data Platform. Through the data we could share with them peak events when the recommended World Health Organisation recommended guidelines were exceeded. We showed them the U.K Government recommended guidelines, which are not aligned with the recommended levels from the WHO guidelines. We also shared the names of organisations locally and nationally who are campaigning for better air quality measures.

This was followed by interactive workshops following the Bristol Approach, to frame people's local experiences and suggestions for change. The outcomes from the workshops and people's voices were documented.

A desire to elevate the voices of the people affected by poor air quality, together with the data informed and inspired an artist commission, called: *Bristol Burning (A Bonfire Nightmare)*. A piece of music composed and produced by composer and artist Miriam Quick, using a process called sonification and vocalist and lyricist, T. Relly.

We also wanted to engage with young people in the neighbourhood around the topic of air pollution. During a conversation with another one of our citizen scientists and St Paul's resident, who worked with young people at the local youth centre, the potential around exploring Minecraft and games to communicate the message was discussed. As a result of this conversation, we created a Minecraft game with a creative technologist and a team from the University of West of England's Digital Engineering, Technology and Innovation department. We delivered the game with young people in 2 two locations in Bristol, Ashley Ward and Filwood Ward . (location of KWMC)

During a final event for the project, we showcased the project findings and outcomes: data, citizen science stories, people's voices and the sonic installation, *Bristol Burning (A Bonfire Nightmare)* .

5.2 DATA AND INFORMATION COLLECTED

The air quality sensors used by the citizen scientists, measure particulate matter PM10 and PM2.5. These sensors were installed in people's homes at different locations in the different neighbourhoods in the Ashley ward, which included St.Paul's, St. Werburgh's and Montpelier.

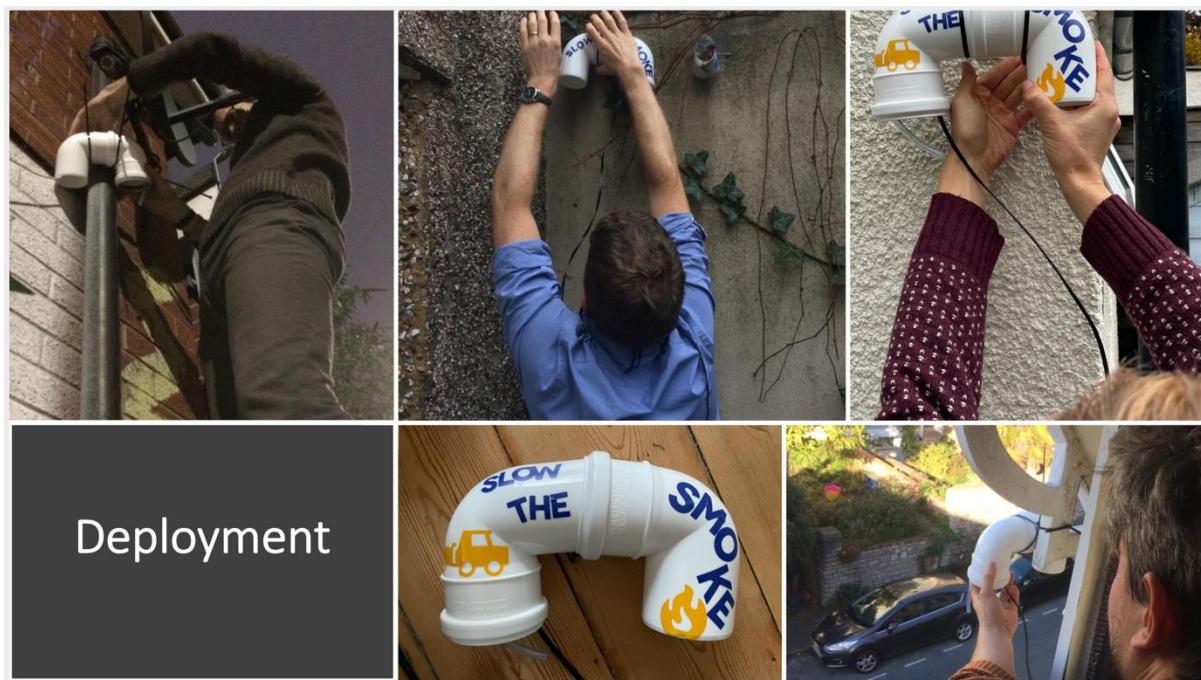


Figure 14. Deployment of DIY air quality sensors by Citizen Scientists in November 2021

The study also involved co-locating some of these sensors alongside high accuracy sensors in the city, to be able to track and evaluate their performance. The data is indicative; however they are on trend with air pollution data from high accuracy sensors in Bristol. In most cases their values were slightly lower than the accurate values presented by the sensors.

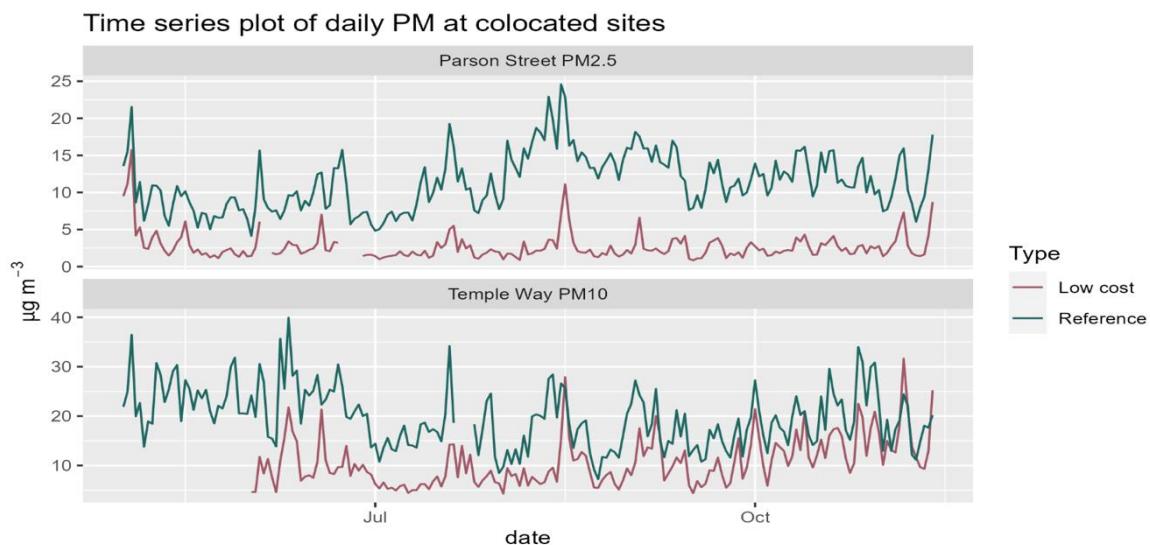


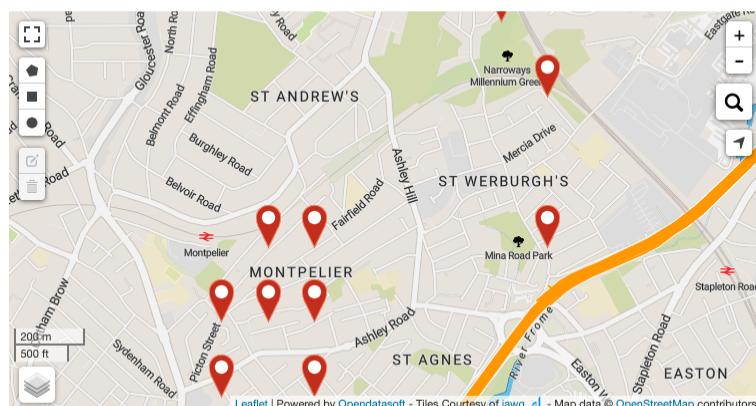
Figure 15. Data display from one of the co-location sites, the red line showing the low-cost DIY sensor data and the green line the accurate reading

The data is viewable as part of an open-source network called sensor community, <https://sensor.community/en/sensors/airrohr/> Bristol City Council also displays this data on the Open Data Platform. KWMC has also developed a tool to look at the sensor data all in one place, which allows for easy comparisons to be made between different sensors.



Figure 16. This map shows the locations of the sensors in the Ashley ward, Bristol on the Sensor Community website. <https://sensor.community/en/>

Slow the Smoke Sensors



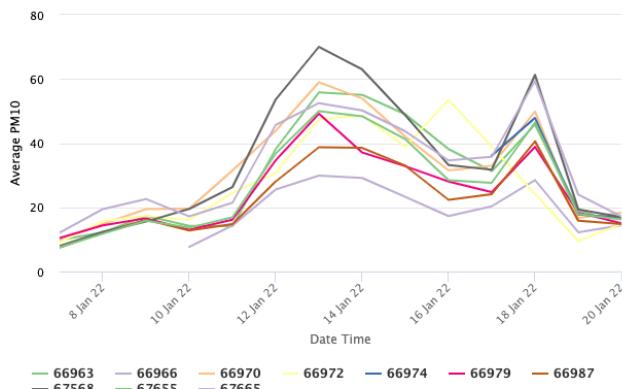
- The sensors are all located in or near the Ashley Ward
- They are low cost sensors indicating levels of PM₁₀ and PM_{2.5} pollution
- They are operated by citizen scientists for the Slow the Smoke project

All dates and times are in Europe/London time.

[-- link to source --](#)

Figure 17. Bristol City Council has extracted this data and displays this on their Open Data Platform. <https://opendata.bristol.gov.uk/pages/homepage/>

January episode (daily data)



All dates and times are in Europe/London time.

-- [link to source](#) --

- From the 10th to the 19th January 2022 there was a pollution "episode".
- Notice how all the lines move together
- This indicates either a regional source dominating
- Or still, cold weather slowing mixing.

Figure 18. Data from the low cost sensors for January displayed on the Bristol City Council Open Data Platform

[Home](#) | [Day of week](#) | [Air quality over time](#)

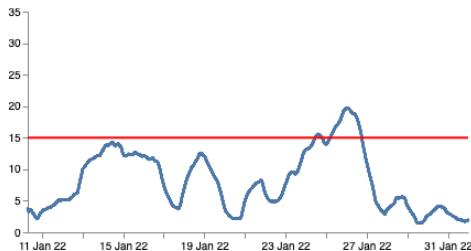
Air quality over time

Particulate size: PM2.5 ▾

The Yard (Stephen) (66963) ▾
January 2022 ▾

Richmond Road (Colin) (66966) ▾
January 2022 ▾

Shows air quality particulate readings as 24 hour means. Each point shows the average air quality reading for the 24 hours preceding it. This lets us measure the air quality against air quality indexes.



Red line indicates the WHO limit

Units: micrograms per metre cubed ($\mu\text{g}/\text{m}^3$)

Source: <http://archive.luftdaten.info/>

Built as part of the Bristol Approach to Citizen Sensing Project with help from Data Unity.



Figure 19. The data visualization tool developed by Data Unity for KWMC indicates the World Health Organisation recommended levels, as below the red line. This tool also allows the viewer to make comparisons between different sensors.

<https://sts.bristolairquality.co.uk/#>

The ongoing engagement with our citizen scientists included a data diary for participants to complete. They were prompted via an email to input any events they noticed, which might provide a narrative to the data from the sensors, humanising it. Below are a couple of examples of observations documented during the month of January.

21/01/2022	Colin at Richmond Road: 66966	Freezing	Arid choking diesel fumes in the street.	A couple of van owners had just got their vehicles defrosted on very cold still morning	I got out of the street ASAP. Very unusual to notice impact on breathing - slightly fearful. I now understand why people in heavy traffic areas complain so much about fumes and also why it's time we banned older diesels altogether.
26/01/2022	Ruth at Horley Road: 66979	Cold	Very smelly with car fumes.	Cars, 8:30 am as I'm walking to work.	We have lit our fire a bit over this month and I have been looking out for woodsmoke to report, but haven't noticed any, however yesterday when my boyfriend came home from climbing around the corner at around 8pm he came in smelling of woodsmoke.

Upon analysis of the data from the sensors, there were no particular events recorded on the individual sensors, but they showed a general picture of poorer air quality during this cold month, which supported the physical events the citizen scientists noticed.

The data diaries were valuable to support a narrative of the air quality data, it also supported the citizen scientists to take notice of what was happening around them.
 Feedback: An app would be useful to have on their smartphone, as they forgot to make entries when they returned home, they also asked for suggestions on specific things to take notice of when they were outside. These suggestions informed the development of the Minecraft game, designing scenarios for the players to interact with.

During our workshops with the communities, we were able to capture some valuable data, through people’s voices and experiences of air pollution where they lived. We were able to identify topics around health, equality, governance, transport and collected lots of feedback from workshop participants around the topic. People also told us their stories of how they or people they know are affected by poor air quality. This data informed both the Minecraft game as well as the artist commission.



Figure 20. Workshop and consultation in St. Paul’s Neighbourhood in May 2022

Inclusion, Equality and Diversity

As part of the Bristol Approach, it is important that equality, diversity and inclusion principles are considered within our recruitment processes to ensure the communities within which the methodology is applied are represented.

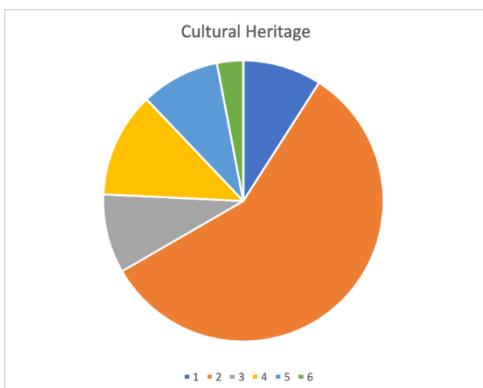
According to the Ashley Ward Profile for September 2022, The Ashley Ward has a total of 33.5% of residents from Black, Asian or other Minority Ethnic groups. The statistics also show 23.8% of the residents were born outside of the UK.

We tried to be as inclusive as possible in our recruitment, by sharing the opportunity with the wide range of BME organisations, and housing organisations who operate in the area. Most of the citizens were recruited via social media, with one via email and one via the local community magazine.

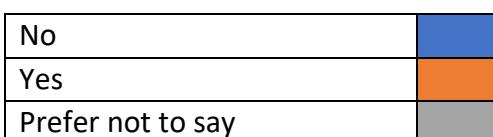
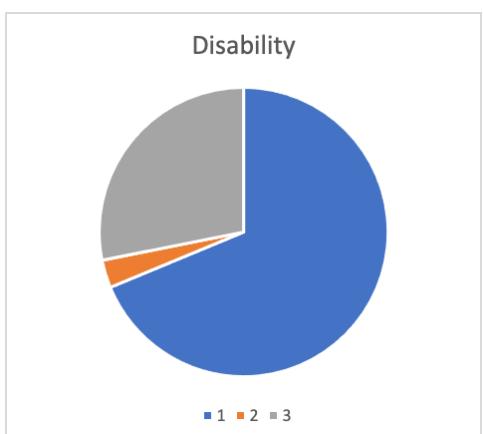
Evaluation

We evaluated the workshops using forms which anonymously captured equality and diversity information.

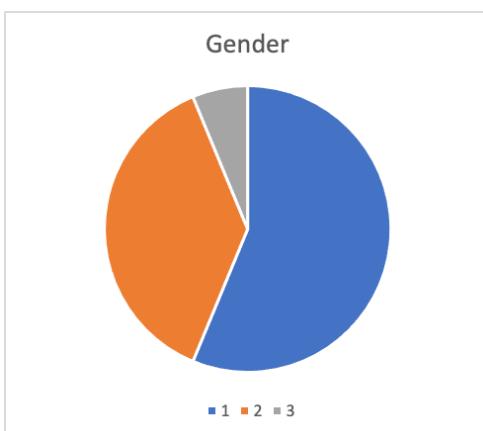
Cultural Heritage



Disability



Gender



Female	
Male	
Prefer not to say	

We also had video interviews with some participants after the workshops. Some of the feedback after the workshops included:

- “A desire to know more about air pollution in my area”
- “I will be much more aware of how much I use my wood burner”
- “I feel more empowered to help my local community”
- “It has been good to focus on the topic of air pollution properly. Seeing the data in front of me and seeing the word -cancer- and -heart problems- pop up. I always had it in my mind, but it has really focused it for me.”
- “I do think differently after the workshop, personally I don’t know if there is anything I can do to change it, I do realise it’s a bigger issue, I guess everybody walking and using public transport, but there is a bigger picture that needs to be addressed.”
- “I feel better informed, but I feel more worried for us local residents’ health and wellbeing. People who are better off can move out of the community, but most of us can’t move out, the inequalities are very clear.”

Accessible Workshops

Accessibility for participants has been an important part of our workshop plan. For example, taking into consideration the diversity of the community in St Paul’s where a large proportion of people have English as their second language, translators were present during the workshop/s.

Accessibility was taken into account when booking venues and when sending invitations, to inquire whether people have access or dietary needs.

However, sometimes, as is the nature of community events, people just turn up, so we did have a few unexpected situations, which we needed to respond to, for example:

We had a wheelchair user join us for the one workshop, who with support was able to access the outside area. To make it easier for her to access the activity workshop, one of the facilitators moved one of the groups outside.

We also had a participant asking for a prayer room, which we were able to respond to, and parents responding to children’s needs, meant we needed to be flexible in delivery of the workshop and work around them.

Working with a childcare provider during the sessions supported people with childcare.

5.3 CONTENT PRODUCED

5.3.1 SONIFICATION - TURNING AIR QUALITY DATA INTO A NEW SONIC ARTWORK

As part of the project scope for Slow the Smoke, we commissioned an artist to explore the air quality narrative. Miriam Quick is a journalist, author and musician who explores novel and diverse ways of communicating data. She co-creates artworks that represent data through sound, images and sculpture. These have been exhibited at museums and galleries internationally.

<https://miriamquick.com/> She hosts a podcast with Duncan Geere, Loud Numbers
<https://www.loudnumbers.net/>. Each episode transforms a data story into a piece of music, using a technique called data sonification.

Understanding local air quality



Figure 21. One of the Slow the Smoke air quality sensors used by citizen scientists

Miriam accessed the data from the air quality sensors outside the participants homes via the Open Data Bristol <https://opendata.bristol.gov.uk/pages/homepage/> portal and used it, along with that gathered by Bristol City Council, to create the music track.

Miriam used the data on one type of pollutant called particulate matter (PM10, a complex mixture of extremely small particles and liquid droplets) from the 14 different sensors in Ashley Ward, over the course of the year from August 1, 2021 to July 31, 2022. As the sensors showed broadly similar readings over time, she took the average reading across all

sensors and then the average by month – reducing hundreds of thousands of datapoints to just 12. This revealed that, on the whole, particulate levels are higher in the winter months.

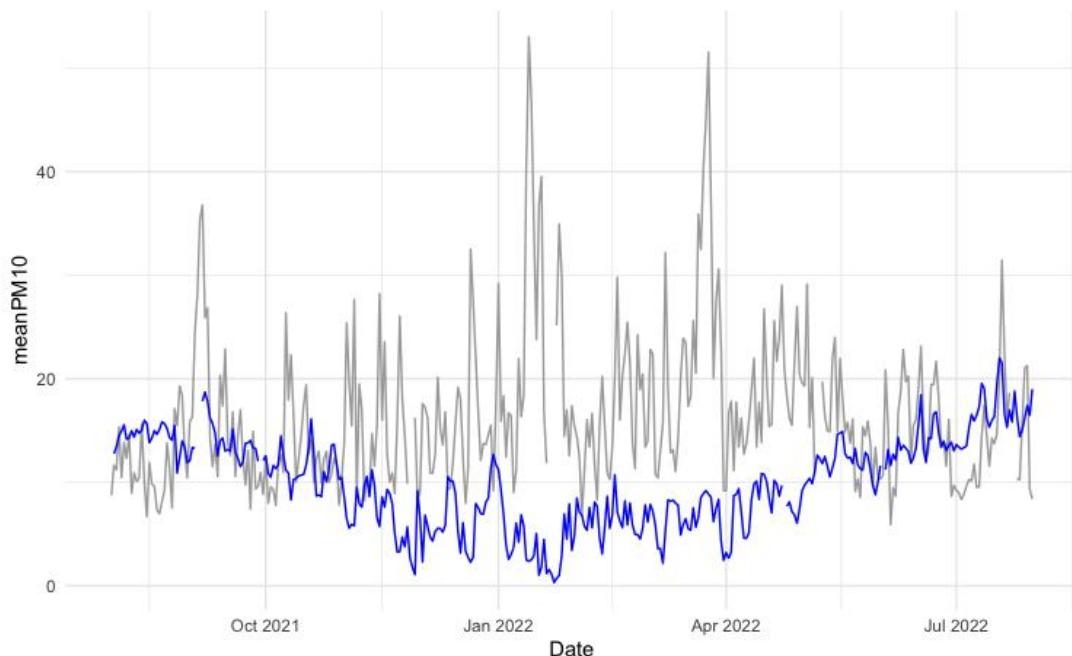


Figure 22. Chart from Bristol City Council sensor at AURN St. Paul's (next to St. Paul's Nursery School) showing daily data over the last year. PM10 (grey) and temperature (blue)

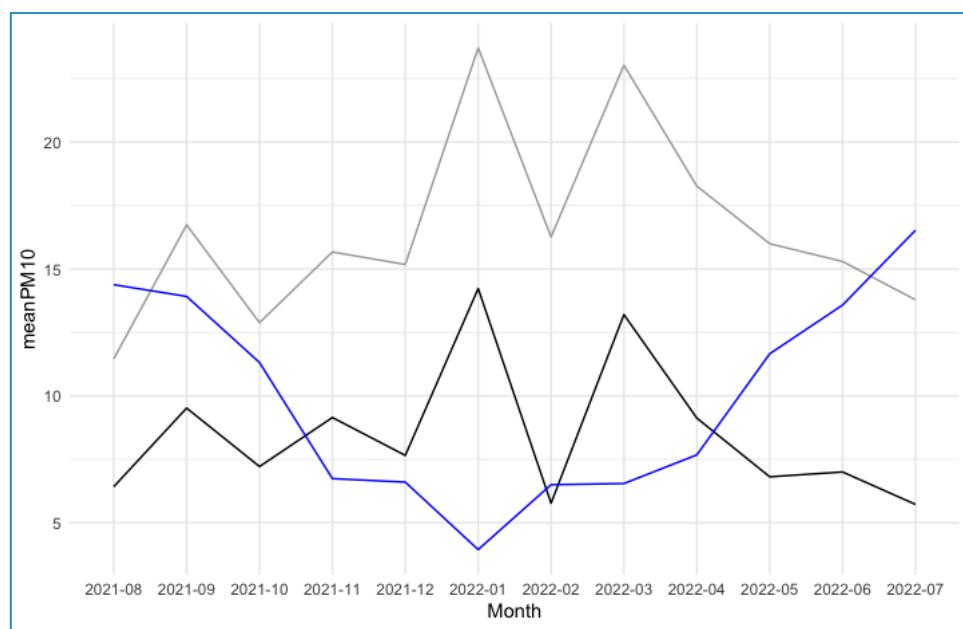


Figure 23. Chart from Bristol City Council sensor at AURN St. Paul's (next to St. Paul's Nursery School) showing monthly average PM10 (light grey), PM2.5 (dark grey) and temperature (blue) over the last year



Figure 24. Monthly average particulate matter (PM10) levels for 14 sensors in Ashley Ward, Bristol from August 2021 to July 2022

Air quality deteriorates in the winter and improves in the summer. Due to a colder air and people's habits. For example fossil fuel combustion caused by higher use of cars, wood burners and fires in homes, closed windows leading lack of ventilation and more concentrated pollution. Sunlight is weaker during this season consequently air nearer the earth's surface may become cooler than the air above, casing the air above to act as a 'lid' and trap the colder pollution-filled air below it.

Transforming the data into music

This broad seasonal pattern is the focus of the track. There are two main layers to the sonification.

Firstly, there's a nasty-sounding drone that gets louder and harsher as the air gets dirtier in the winter. (The data is mapped to the volume and cut-off of a low-pass filter.) When the air quality is very bad, this drone is so loud it dominates everything. It's meant to sound really horrible! When the air cleans up again in the spring, the drone gets quieter and fades out.

Secondly, a dub track plays at the same time as the drone. It responds to the data in the opposite way: instead of getting louder when levels are higher, the music gets quieter. This music track is representing the people living in Bristol. When air quality gets really bad in the winter, it's like the drone is drowning people out and stopping them from living their lives. Which is exactly what air pollution does, even at low concentrations: it makes us sick and stops us living our lives to the full. You actually don't hear the music at full volume until right at the end of the track, when you realise what you've been missing the whole time.

The Software used:

R studio for data analysis

Sonic Pi / VCV rack for sonification

Logic Pro for music production



Figure 25. The sonification was made in Logic Pro

T.Relly, is a renowned hip-hop artist in Bristol who grew up in St Paul's neighbourhood. Relly has links with the city' major club nights, but also a passion and support for Bristol's most disadvantaged through his work in youth services and with prison leavers. He created the vocals and wrote the lyrics, an invaluable human dimension to the data.

<https://lnk.to/Ree-VoEDDA52>

<https://ree-vo1.bandcamp.com/album/all-welcome-on-planet-ree-vo>



Figure 26. Recording session T. Relly at Hamilton House, Stokes Croft, St. Paul's

We also recorded voices from members of the local community in St. Paul's. In the track you can hear the names of the months spoken out loud (August, September and so on), like audio labels telling you what point you are at in the year. These were recorded by lots of different people during a workshop with the community, where we explored data sonification and invited people to record their contributions.

Sound the Air. Community event and Sonification workshop



Figure 27. Sound the Air event: Stokes Croft, St. Paul's October 2022

The aims of the workshop were to record sounds from the community and to introduce the concept of sonification through various activities. We set up the room into stations, where the participants could go on a journey through the artists' process: understanding air quality data; exploring sonification by experimenting with soundmaking with data activities and recording their sounds and voices to be added to the track.

In a separate room we had the recording equipment set up, where T.Relly's vocals for the track was recorded earlier on the day.

17 adults and 8 children attend this workshop.



Figure 28. The room was set up in different stations, which worked very well within the space and also to accommodate people who came at different times

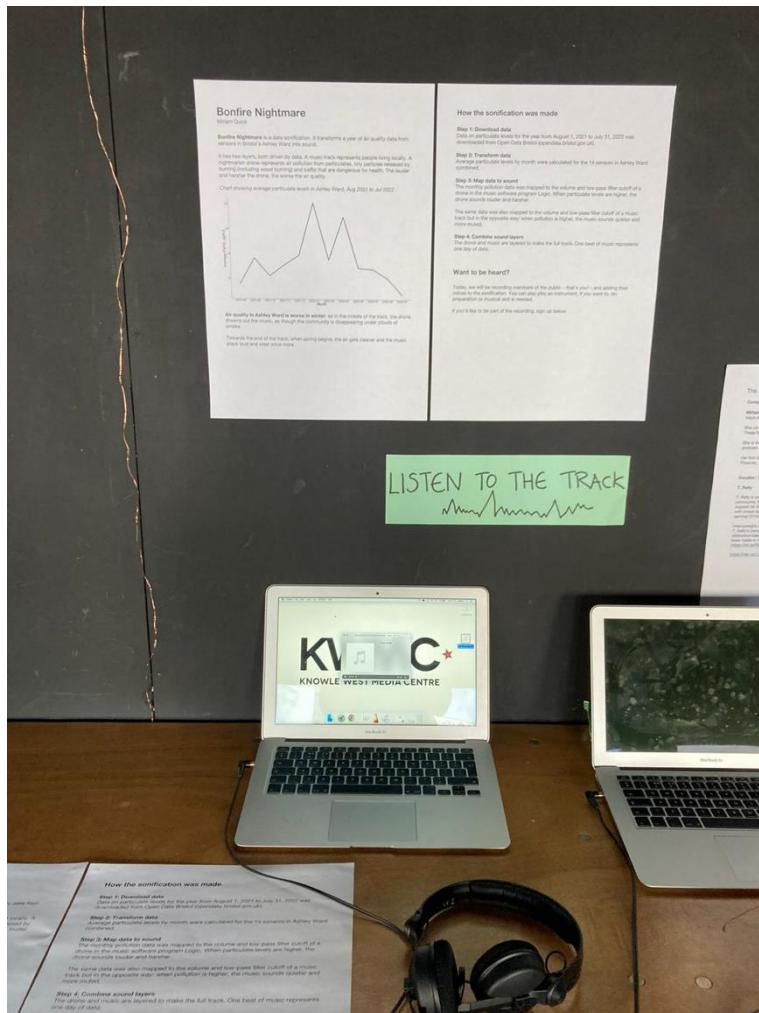


Figure 29. This was the listening station. Listen to the track and get an overview of the sonification process and the meaning of the different sounds, especially the drone used in the track



Figure 30. Percussion artist, Ed Allen had a selection of “sound making objects”. Some of these included objects which could mimic the wind, or rain. Children also enjoyed making their own drums

The artist, Miriam Quick designed a selection of sonification activities. They all explored data and soundmaking at different degrees of complexities. One activity, Play the Weather explored weather data; wind and temperatures. People could join in this together as a group, it was physical and fun.

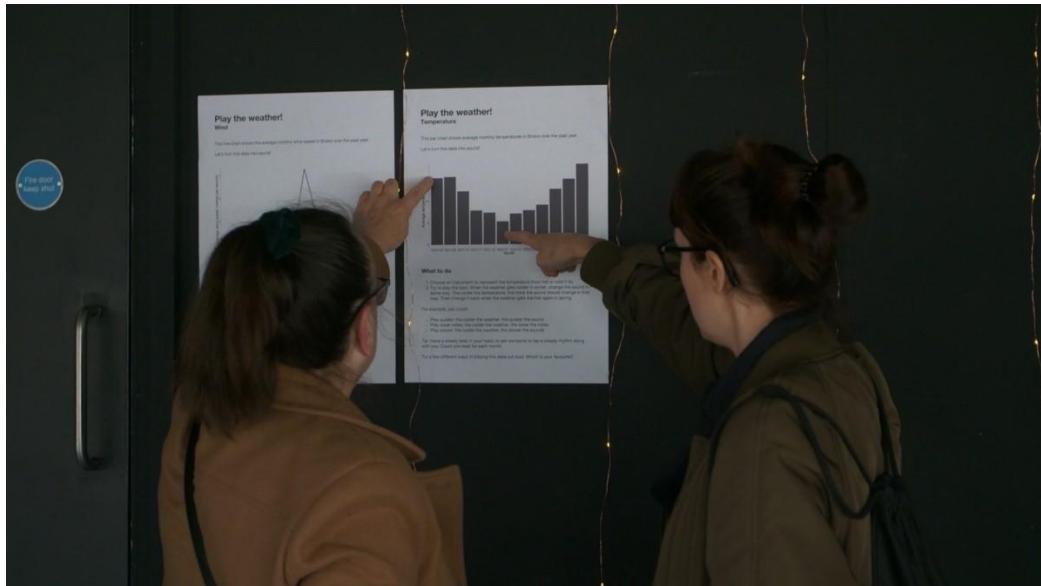
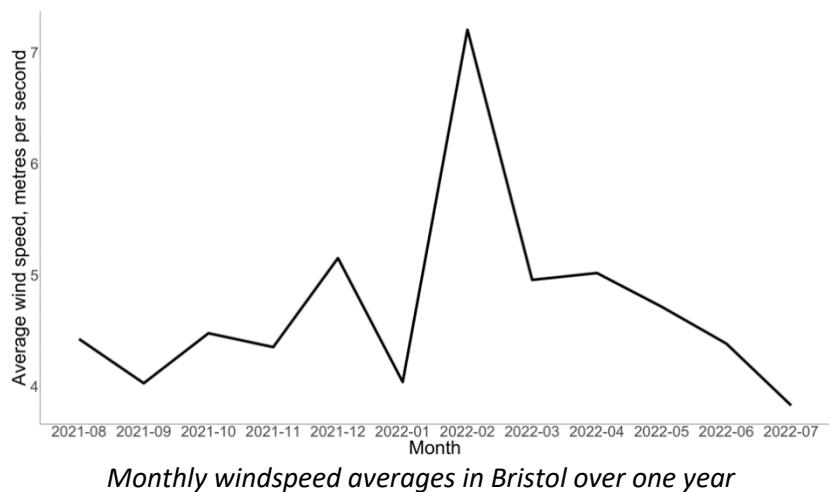


Figure 31. Miriam Quick, the artist explaining the activity Play the Weather to a participant

Activity: Play the Weather - Wind

This line chart shows the average monthly wind speed in Bristol over the past year.
Let's turn this data into sound!



What to do

1. Choose an instrument to represent the wind.
2. Try to play the line. When the wind blows faster, change the sound in some way.
The faster the wind, the more the sound should change in that way.

For example, you could:

- Play louder: the faster the wind, the louder the sound
- Play higher notes: the faster the wind, the higher the notes
- Play faster: the faster the wind, the faster the sounds

Tip: Have a steady beat in your head, or ask someone to tap a steady rhythm along with you. Count one beat for each month.

Figure 32. Sonification Activity for Play the Weather



Figure 33. Participants doing the weather sonification activity Play the Weather: Wind

Most of the participants recorded their sounds and voices after the workshop. It was a novel experience for many, especially the children enjoyed the process and excitement to be featured on a music track.



Figure 34. The recording room was set up in a different location. Participants recorded their sound contributions after exploring sonification in the workshop

Feedback from the workshop

“When you play the music quieter it feels peaceful, and then it gets intense and your body reacts with that. I think it is a good experience for the children especially. It was good to



understand how your body changes and your senses and then think about pollution and looking at data more closely and really interpreting that through using your senses and sound, it was great."

Figure 35. Tara, St.Paul's resident and workshop participant

"I liked the approach of translating data into sound, so that it is able

to touch people emotionally and not only convince them to change behaviour based on reason."

Workshop Participant

Showcase Event

Bristol Burning (A Bonfire Nightmare) Track Debut

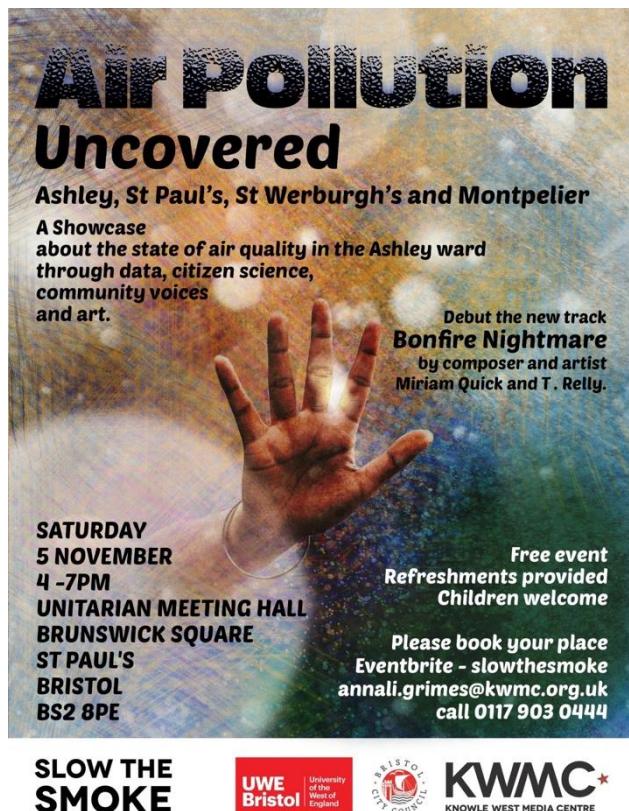


Figure 36. Final showcase event invitation for Slow the Smoke in November 2022

We had a final event and showcase on Bonfire Night, 5 November 2022 in Bristol, where we showcased all the findings from the Slow the Smoke project through data, citizen science, community voices and art. We had 16 adults and 8 children attend the event. An exhibition showcasing the different data narratives as interpreted by the community, gave visitors an insight into the project.



Figure 37. Slow the Smoke final showcase event in November 2022, St. Paul's

The highlight of the evening was the debut of the artist commission, *Bristol Burning (A Bonfire Nightmare)* accompanied by an animation created to support the data narrative. The track was followed by a Q ‘n A with both artists Miriam Quick and T. Relly, to be turned into a podcast and released alongside the track with an accompanying video planned for early Spring 2023.

The track was well received, however because of the acoustics in the venue, some of the lyrics got lost as the track is very reliant on a good bass speaker. We are working with the artist to remaster this.

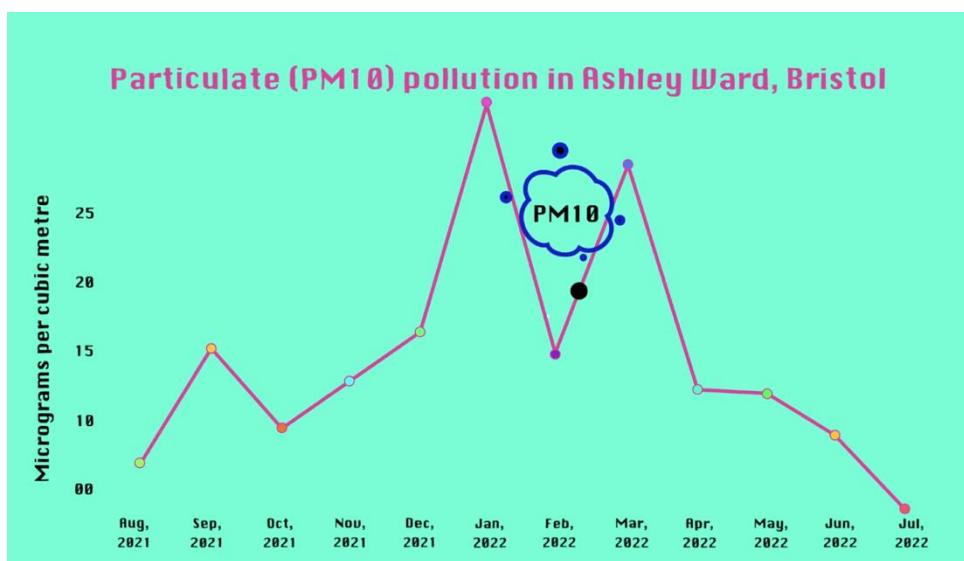


Figure 38. Animation showing the data narrative which accompanied the track: Bristol is Burning (A Bonfire Nightmare)



Figure 39. Q n A with the artists Miriam Quick and T. Relly at the final showcase event for Slow the Smoke in November 2022

During the event we started conversations with local community members about next steps to inform the launch of the track. As part of our engagement using the Bristol Approach, we designed assets with the community, however these needs to be placed back in the hands of the community. As a continuation of the project, KWMC will work alongside people and organisations from the neighbourhoods involved in the project and local press to plan and release this track as part of an air quality awareness campaign, which is citizen led.

We finished off the evening with a delicious meal prepared by a local chef in St. Paul’s, allowing for more conversations and networking.

Feedback

“Important showcase”

“Good event”

“I liked the showcase, especially that we could see and touch the used materials and the game. The agenda of the evening made the approach accessible and was consistent.”

5.3.2 Minecraft – Gaming as a form of Data storytelling

One of the groups we wanted to engage with as part of the Slow the Smoke Project, was young people. We got in touch with Docklands Youth Club, through one of our citizen scientists who worked with young people. We decided through a Minecraft game design, to communicate, inform and educate about air pollution in St. Paul’s.

The team consisted of Dan Tagg, a creative technologist <http://wildmanherring.com/> who has experience of manipulating Minecraft for educational purposes, to support the data narrative within the game. We received support from the outreach team at University of West of England Digital Engineering Technology and Innovation Department (UWE DETI), who has experience in delivering workshops with young people using Minecraft as a tool to encourage young people to think more creatively about engineering.

<https://www.uwe.ac.uk/about/values-vision-strategy/partnerships/department-partnerships/engineering-design-and-mathematics/deti>

We offered the workshop during two youth club settings, one in St. Paul’s neighbourhood, in the locality of the Ashley ward and one in Knowle West at KWMC. The young people attending both the sessions have played Minecraft before, with different levels of experience.

The intention of the workshops was to involve the participants in the co-design of the Minecraft game as a tool to educate young people about air pollution. We had breaks in between to get feedback on their experience, we also had the opportunity to observe their interactions and their design choices. We had a total of 13 people attending the workshops, which was a lower number than we had hoped for. There was a low attendance at the youth club settings themselves, likely due to adverse weather on both evenings. (All the young people who attended the sessions, were playing Minecraft.)

However, the learnings from the workshops were very useful to support the game development and how to frame the content in a timely manner, responding to how the individuals play the game.

It was especially helpful to inform us how to interject the fun element consistently during the game. The young people were 100% engaged throughout both the sessions and they reported the session as “fun”.



Figure 40. Minecraft workshop 1 in St. Paul’s in October 2022



Figure 41. Minecraft workshop 2 in Knowle West in October 2022

The Aim of the Game

The aim of the game is to lower air pollution for the neighbourhoods in the Ashley ward.

The game is played in *Creative Multiplayer Java Mode* and utilises the private Minecraft server set up at KWMC. By installing the game on multiple laptops, there is potential to travel the workshop to other groups in the city. Whilst the multiplayer mode is a very important part of the game, it requires a robust internet connection in order to play. If this is not the case the realm can still be played in single player mode. We have not tested it with young people in this mode, however have found the social interaction in the multiplayer mode a very important motivator for the groups.

Creating the Bristol world in Minecraft

We imported a rendered map for the neighbourhoods of St Paul’s and St. Werburgh’s into Minecraft, which was provided by UWE DETI, created by their partners at Atkins.

<https://www.atkinsglobal.com/>.

Within the map we identified three zones, which was a very important design element of the game.

The areas were highlighted to achieve the aims of the game, but also held significance based in reality from the experiences of our citizen scientists and residents who attended previous community workshops in St. Paul’s and St. Werburgh’s.

The Zones

The three zones support with translating the real-world map into Minecraft. The Yellow Zone is focused around St. Paul’s Adventure Playpark, which is adjacent to the M32 motorway; the Red Zone includes the congested Mina Road, used as a cut-through the neighbourhood by vehicles to and from the M32 motorway; the Green Zone includes St. Werburgh’s Primary School and Nursery, where families are exposed to ambient air pollution from idling cars stuck in traffic during the school run.

The zones also allowed us to focus the interventions in the game design, whilst preventing people to drift off and lose interest. Colour coded beams supports the players with navigating around the zones within the world and to help them find other players.

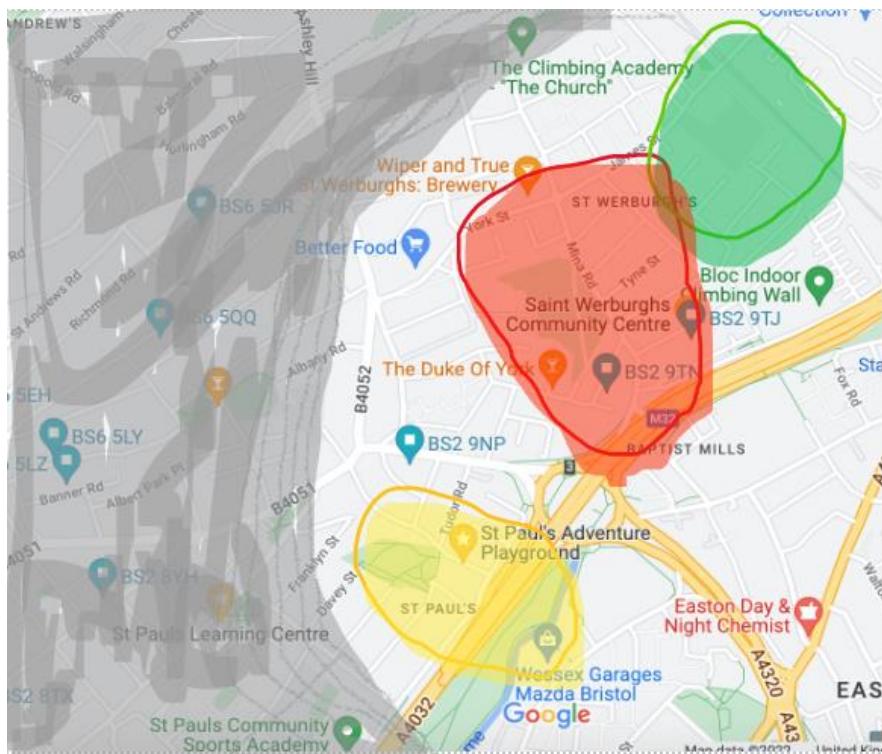


Figure 42. The different zones in the Bristol Minecraft world



Figure 43. Different colour beams supported navigation in the Minecraft game

Creating the Data Narrative within the game

The aim was to represent and communicate the air quality data within the Minecraft world and for this data to be gamified, thus informing the progress status of the players. If the air quality values are low, they are successful, if the air quality values are high, they need to take actions.

The data from the citizen scientists' low-cost sensors showed similar results of PM10 and PM2.5 at different sensor locations within the neighbourhood, so we decided to use one set of data values to represent the whole Minecraft world.

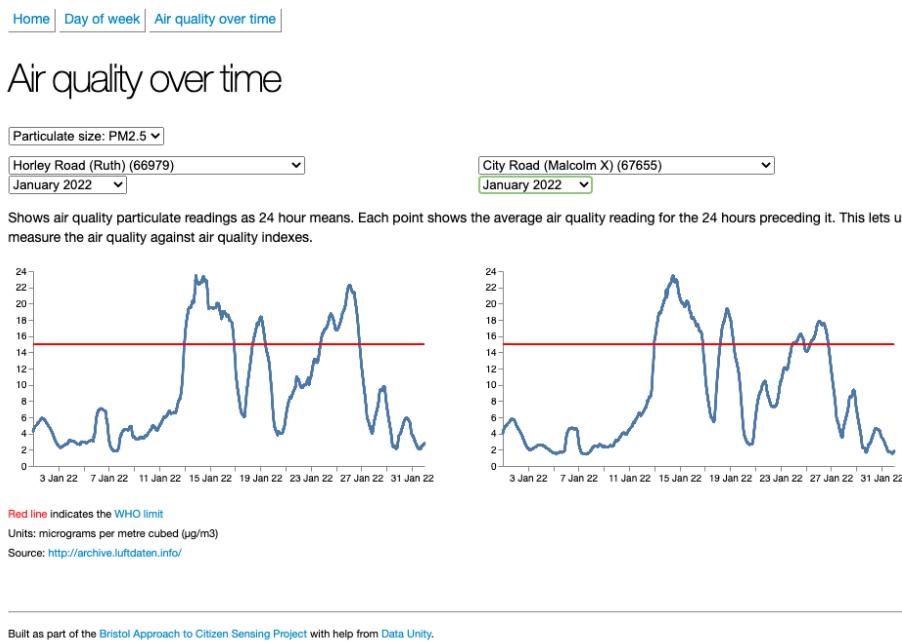


Figure 44. Data visualisation of 2 different low-cost DIY air quality sensors in St. Paul's and St. Werburgh's showing similar results

Gamifying the data

In order to differentiate between high or low air quality data values, we aligned the air quality data values with the colour of the sky, showing red when the levels were high, and a bright clear sky when the values were low. However, when playing the game, we observed that Minecraft follows its own timeline, which also changes the colour of the sky during daytime or night time. We overcame this by supporting the functionality with pop-up messages for the players, to indicate the air quality values: showing the number, as well as whether it was high or low, with a prompt to take action.

These pop-up messages could also be added manually while playing the game by the facilitator, thus responding to the actions (or inactions) of the players.

We identified 3 activities within the game which impacted air quality data values, when performed by the players. These were putting fires out, removing cars and planting trees. Playing in multiplayer mode (collectively) all of the actions from the players working together affect the air quality levels in the Minecraft world.



Figure 45. Activity 1. Putting the fires out coming from the buildings and design better solutions to how we can heat our homes

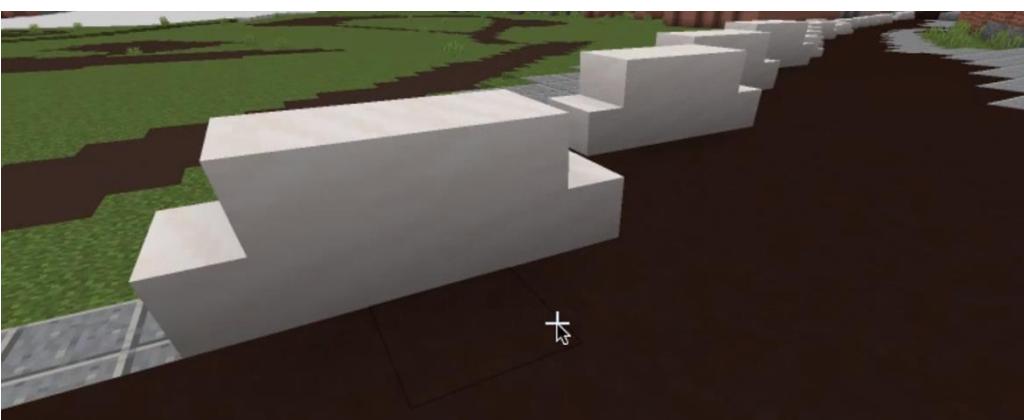


Figure 46. Activity 2. Remove the cars and design better transport solutions

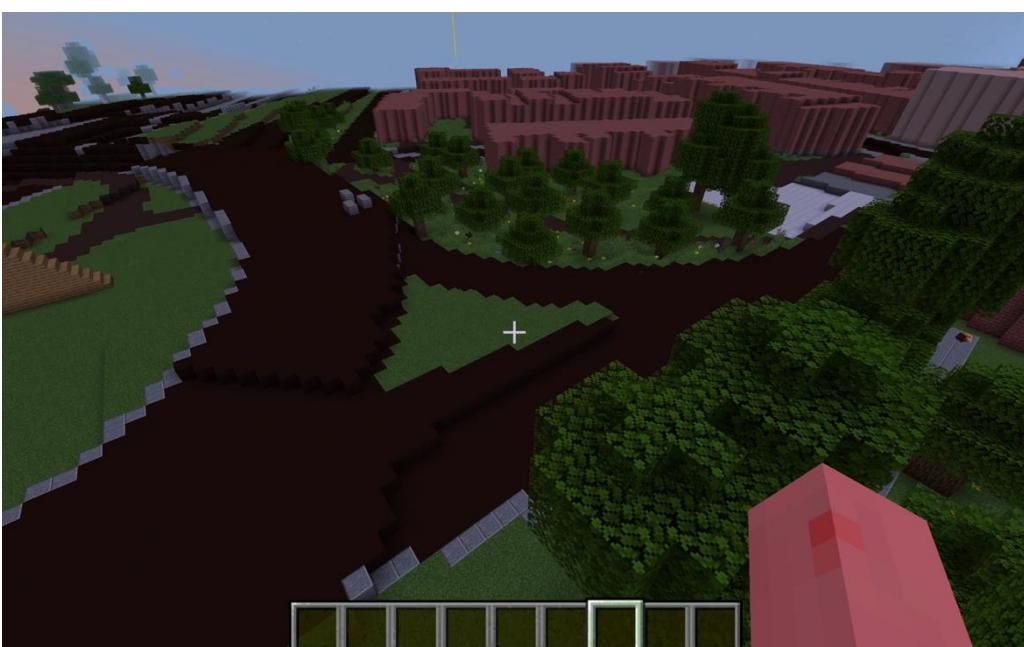


Figure 47. Activity 3. Plant more trees and redesign urban environments

The actions were introduced systematically by the facilitator during the game under the three themes: Transport, heating our homes and the number of trees and green spaces in our neighbourhoods.

After each action was introduced, and experimented with by the players, there was an opportunity to break out for a discussion about the theory around the topic and to expand on this task in prompting the players to come up with better design solutions for transport, heating our homes and urban design. This allowed for creativity from the players and the outcomes were shared with the group at the end of the session.

Observations of the game

- After putting out the fires, one of the players put solar panels on roofs, another player added bicycles after removing the cars. All the players enjoyed planting trees and creating forests.
- One Player introduced animals, others followed suit and started farming, allowing for conversations around locally grown food vs transporting it from other areas.
- One of the players introduced bees and planted flowers, which led to conversations about biodiversity and how bees and birds are also affected by poor air quality and lack of bee friendly fauna and flora.
- When the player introduced the bicycles, another player started removing the bicycles, which led to a conversation about everyone doing their bit and an understanding of working collectively.
- Group 1 in St. Paul's, who were all friends, immediately looked for each other inside the game and built houses next to each other. They were able to recognise landmarks and have a familiarity with the area.
- Group 2 in Knowle West were playing in the same world, which was not their neighbourhood consequently not familiar to them. So decided to teamed up with the person next to them by finding them within the game using the locator.
- A more experienced player introduced humans, who needed to be given homes and jobs to carry out - otherwise they would start fires and cause havoc! This added a lot of fun to the game, and was a good way to inject jeopardy complication to the game.
- The players who had more experience supported the newer players



Figure 48. Solar panels on roofs as solutions to heating our homes

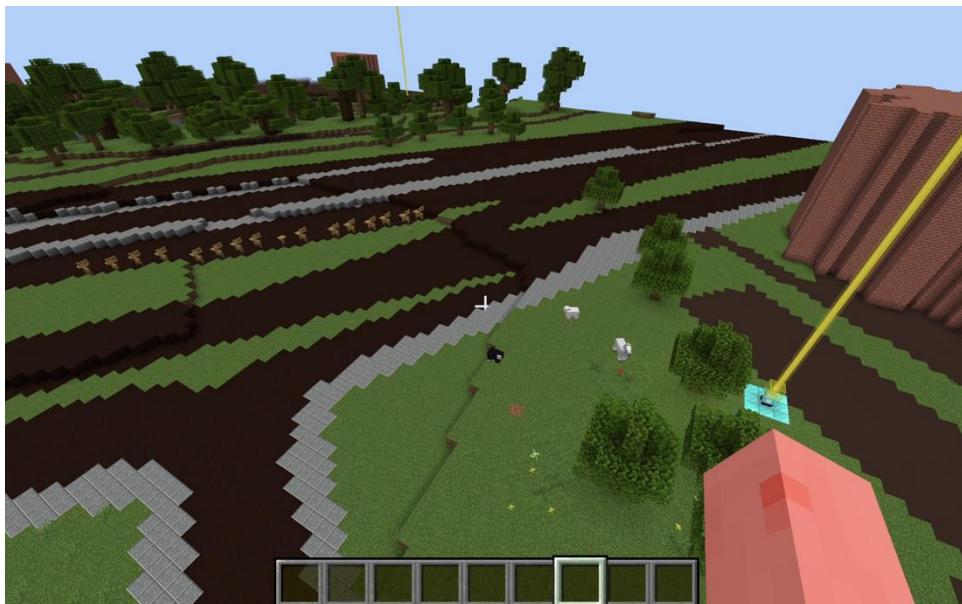


Figure 49. Introducing bicycles as solutions to cars on the road



Figure 50. Introducing bees and urban gardens

Feedback

- “Fun”
- “ learned we need to stop driving so much”
- “I learned about air pollution”
- “Yes I would play it again”

5.4 KEY LEARNINGS

Citizen Scientists:

- To ensure more consistent readings from the air quality sensing equipment – consider solar powered devices with batteries connected to LoRaWAN
- We can empower the citizen scientists more to be able to create their own narratives with the data from their own sensors, to be able to talk to others about their findings in a meaningful way.

Community workshops:

- People attend these workshops with an agenda of their own. Be flexible to adapt the workshop to accommodate experiences brought on the day.
- Plan the workshops with trusted organisations who work in the area, our family focused workshop was very successful as a family day, with really good engagement and enthusiasm from the participants. Word of mouth invitations and Whatsapp groups worked very effectively.
- Eventbrite invites is not necessarily a sign of attendance numbers, we had much higher booking numbers, than our attendance numbers showed.
- People appreciated the hot meals which we provided with the workshops

Sonification:

- Telling data stories using the sonification technique and through the body experientially opens up the participants' understanding of the data on a deep personal level. By experiencing the data through one's senses it is demystified. This gives a person a new position/point of view from which to approach the information.
- Test the venue booked for acoustics when performing a piece of music.
- The sonification physical workshops were so fun, a good tool to take into any other data workshops.

Minecraft:

- To get better attendance numbers, schools might need to be considered, but this might hold firewall issues with the server. Promoting it with STEM clubs potentially.
- Put people straight into the game to keep their interest.
- The game has a lot of teaching potential.
- Include a physical activity outside of the room to support the team building design activities.
- Having the map of the exact neighbourhood is an exciting feature, but the game is transferable to other neighbourhoods in Bristol as well.
- Keep it fun!

5.5 NEXT STEPS

- Remastering of the track, *Bristol is Burning (A Bonfire Nightmare)* early in the new year.
- Production of a short video to support the track, alongside the Q n A with the artists.
- Engage with the local community in Ashley to share the outcomes, which were created from the Slow the Smoke project, and create a local campaign to distribute the materials and raise awareness of the issue locally – early Spring.
- Further outreach to offer Minecraft workshops at secondary school settings or STEM clubs across the city.

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