

Transitioning to a circular economy for plastics with an artist in residence (TRACE-P)

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HIGHLIGHTS

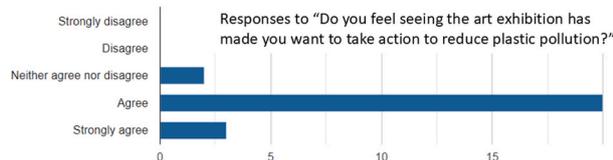
- Study assessed the CIN-ART concept with focus on plastic wastes & consequences.
- Involved artist-in-residence, academics/professionals, creation/exhibition artwork.
- Artwork successful in encouraging reflection on impact of consumerist behaviour.
- Artwork successful in educating on plastic pollution & creating emotional response.
- Partnership with artists speeds up translation of circular economy principles.

GRAPHICAL ABSTRACT

EXHIBITION:



RESPONSE TO EXHIBITION:



ARTICLE INFO

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ABSTRACT

Methods for science communication about the harms caused by plastic wastes have been ineffective in stimulating change. This study assessed if combining intergenerational influence and the skills of creative artists enables enhanced communication of scientific/engineering principles to the public (the COM-ART concept), with a focus on plastic wastes and its consequences. It involved discussions between a university artist-in-residence and specialist academics/professionals, creation/exhibition of artwork, and an associated social survey. The study demonstrated that the COM-ART concept has considerable potential as an approach to improve scientific communication and stimulate change based on scientific evidence. Results showed the artwork was successful in: i) educating people about sources and impacts of plastic pollution ii) creating an emotional response from viewers iii) encouraging people to reduce their plastic usage and question the impact of their lifestyles on the environment.

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1. Introduction

1.1. Communicating an environmental message about plastic pollution

Plastic pollution is ubiquitous across the Earth, from the depths of the ocean (Mohrig, 2020) to the heights of the Himalayas (Yang et al., 2021), harming wildlife and environments, and spreading toxic chemicals (Macleod et al., 2021). Plastic breaks down, eventually leading to microplastic and nanoplastic pollution (Hu et al., 2019). Plastic pollution is one of the fastest growing global environmental challenges (Jambeck et al., 2015), with research indicating the problem may be worse than previously estimated (Way et al., 2022).

Microplastics can be characterised by types/structure, shape (angular, irregular, elongated, broken edges, etc), state of erosion, colour, and origin/source. Types are usually divided into fibres, films, fragments, foams and granules, the latter comprising spheres, beads, and pellets (Hartmann et al. 2019). While most of these are rigid particles, fibres and film are more flexible in their morphology. Primary microplastics are purposely produced for an array of purposes and are found in a diverse range of products (Landeros Gonzalez et al., 2022). Secondary microplastics are irregular particles originating from the fragmentation of larger plastic pieces due to UV radiation, mechanical forces and/or biological degradation (Weithmann et al., 2018).

Microplastics come from many sources, including accidental spills, wastewater treatment processes, personal care and cosmetics products, industrial abrasives and cleaning agents, mismanaged wastes, road markings, vehicle/tyres, construction/roadwork activities, atmospheric debris, exterior paints, and items of personal footwear/clothing, and laundry (Landeros Gonzalez et al., 2022; Gao et al., 2024; Hoeke et al., 2024; Sivyer et al., 2024). These are able to enter the human body, with microplastics found in human blood (Leslie et al., 2022).

Emissions of plastic have continued to grow and are expected to reach 53 million metric tons annually by 2030 (Borrelle et al., 2020). The current levels of plastic waste are creating potentially irreversible harm to the environment and so it is therefore essential that the future levels of plastic pollution are reduced (Chen et al., 2020). The impact of microplastics on human health has been highlighted as a particularly distressing issue for the public (Deng et al., 2020), with reports they are now extremely concerned over the potential human health impacts of marine plastic pollution, with strong public support for further research (Davison et al., 2021).

Plastic when used and disposed of correctly brings many benefits to society, but the incorrect disposal of plastic creates many negative consequences. Whilst governments should be responsible for providing suitable infrastructure, individuals can take many actions to reduce the plastic pollution they create. If the plastic pollution crisis is to be addressed, it is vital that awareness of plastic pollution and correct methods of disposal are increased among the public. Raising public awareness of plastic pollution motivates reduced consumption, stronger recycling and support for systemic change that enable a circular plastics economy. Informed citizens pressure governments and industry to redesign products, invest in collection and reuse systems, and back policies that keep materials in use longer. Awareness campaigns accelerate market demand for circular solutions, improve waste sorting behaviours, and build political will for regulations and infrastructure needed to close the plastics loop faster and fairer (EMF, n/d). Societal challenges include unequal waste burdens on low-income communities, informal sector livelihoods dependent on waste picking, behavioural barriers to source separation, and lack of trust in institutions. Addressing social equity, worker formalization, public education, and inclusive policy design is essential to ensure plastics circularity is just and effective sustainably.

Accelerating effective large-scale plastic waste management requires active public engagement and motivation and this is immensely challenging. Thompson (2019) demonstrated that plastic pollution has been thrust into the global limelight by a combination of scientific progress,

public discussion and media coverage (e.g. TV programmes such as Blue Planet II). Consequently, a number of political, environmental, social, technological, legal, and economic approaches have been trialled - including policy responses by national governments, the European Commission, the G20, the Ocean Plastics Charter and the United Nations Environment Programme. However, only slow progress has been achieved (Williams, 2023), impeded by the plastics industry's determination to resist government regulation, redirect accountability, and obstruct critics, combined with its promotion of corporate self-regulation and consumer responsibility as principles of governance (Dauvergne, 2018).

To add complication, public risk perception of microplastics contrasts with current scientific evidence, with public concerns being higher than scientific evidence on the health and environmental risks of microplastics would justify (Kramm et al., 2022). This is due to multifarious factors, including:

- The ease of accessibility to, and impact of, high profile media reports and public campaigns.
- The different risk conceptions between the public and scientists (Kramm et al., 2022).
- Because scientists commonly encounter substantial difficulties in communicating research findings to the public in a manner that results in effective change (Brock et al., 2022).

Scientific communication is the practice of communicating science-related topics – science, technology, engineering, and maths – to non-experts. In a world full of competitive media organisations and “fake news”, scientific communication is increasingly challenging. Scientific concepts are often intricate and require a deep understanding of the subject. Simplifying these concepts without losing accuracy is difficult. Scientists use specialized terminology that can be hard for non-experts to understand. Scientists must communicate with various audiences, including peers, policymakers, and the general public. Each group requires a different approach and level of detail. Ensuring that communication is ethical and does not mislead or cause harm is essential, and this involves being transparent about uncertainties and limitations, which adds complexity. Making scientific information engaging and relevant to the audience is vital and this often requires creativity and storytelling skills in addition to subject expertise. Science communication must be sensitive to cultural differences and varying levels of scientific literacy across different regions and communities. Communication about environmental issues is especially challenging, particularly when the scientific evidence points to severe adverse impacts on public health and ecosystems, leading the public to “switch off” to avoid feelings of despair, sadness and helplessness. All these factors combine to make contemporary scientific communication an increasingly complex and nuanced task.

Traditional methods of public communication tend to have limited, mainly short-term impacts (Williams, 2023). Even very high-profile campaigns – for example, the use of children's TV characters “The Wombles” to highlight the problem of littering – did not stop litter (Williams, 2023). Few interventions have addressed the underlying social dimension required to inform advancements towards global sustainability for plastics - both quantitative and qualitative methods are required to solve complex human-environment interactions (Bercht, 2021). Heidbreder et al. (2019) highlights the urgent requirement “to improve current interventions and to create additional powerful, immediate, and global solutions to limit the amount of plastic waste in the environment”. Kramm et al. (2022) emphasise the need to “find solutions to the larger plastic problem and examine individual responsibility and behaviour regarding plastic consumption”.

One method for raising awareness of an issue is through the medium of art. There is a long history of art being used to communicate problems within society, such as medieval artwork depicting the black death as a divine punishment, Steen's “The effects of intemperance” (1662)

highlighting the impacts of excessive drinking, and Dix's "Shock troops advance under gas" (1924), Fleming's "wounded soldiers at Sanches, Flanders" (1917) and Picasso's "Guernica" (1937) highlighting the horrors of war. Claude Monet's conceptual art, especially his London Series paintings at the turn of the 20th century, were influential in terms of examining humans' relations to nature. However, the environmental art movement did not emerge until the 1960s when individuals such as Nils Udo, Jean-Max Albert and Piotr Kowalski laid the foundations for this form of art expression, followed by artists such as Robert Morris, Chris Jordan, Andy Goldworthy, and Agnes Denes (Brock et al., 2022). The pressure group Greenpeace has often used art to inspire action for social and environmental change (Kuen, 2022). Art has the capacity to convey an issue in a highly emotional way, which may be able to raise awareness, promote reflection and encourage behavioural change. Nevertheless, most artwork crafted to communicate an environmental message was not done so with this purpose in mind. Hence, although nature/environment has long been a stimulus for artists, the value/outcomes from making environmental scientific topics visible via art has not really been tested (Madden et al., 2022).

However, there is currently a lack of evidence that any of these artworks have had a clear impact on policy, society, and personal change. Many of them were created as a response to ongoing changes within society and the emerging zeitgeist during that period, rather than clearly being the cause of that change. A good example of this is the anti-war movement, which would have existed with or without the existence of anti-war artworks such as those created by Dix. Picasso's Guernica has become symbolic of the anti-war movement, with a full-sized copy hanging in the United Nations New York Headquarters. However, it is unclear how much if any change this artwork actually brought about and if its fame is due to the message it communicates, or the fact it was created by one of the 20th century's most iconic artists. Due to a lack of studies taking place at the time, it is very difficult to measure and ascertain beyond anecdotal evidence the impact any of these artworks created regarding changes to policy, society, and individuals. Paula Rego's abortion series has been credited with changing public opinion on abortion in Portugal and encouraging a referendum on the matter, however, this is a subjective assessment, and it is once again difficult to measure. Considering nearly all European countries allow abortion (95 % of European women live in countries where it is allowed) it is unclear if this artwork was really a key factor in the Portuguese case or not.

One area where art has potentially been highly effective for encouraging social and personal change is when it has been created for propaganda purposes. A good example of this is the iconic illustration created by Alfred Leete, "Lord Kitchener Wants You", the publication of which in September 1914 saw the highest monthly number of new volunteers enlisting in the British army during the whole of World War 1. In this case, the impact of the artwork is clearer. Whilst the artistic merits of this work are debatable, the impact it created is clear. Other examples include Kustodiev's "The Bolshevik" (1920), and "Long Live Chairman Mao!" (1971) produced by the Revolutionary Committee and Propaganda Team of the Workers of the Shanghai Fine Arts School, two images which remain iconic to the present day in their respective countries.

Whilst the power behind those creating and pushing the artwork used as propaganda may largely be responsible for its impact, it may also be possible that there is an element of their design that makes them more impactful. Propaganda art is often very simple with a clear message and has little room for interpretation, and the meaning may even be clearly stated with words incorporated into the art. If art is to be created with creating an impact as the primary target, then perhaps there are lessons to be learnt from propaganda artwork. It may be useful to have an exact outcome in mind, which can then be measured. In propaganda, the artwork is secondary to the message being communicated, which may go against an artist's creative instincts but perhaps would deliver greater impact and make it easier to measure that impact. Environmental issues have become increasingly politicised, and using propaganda style

artwork may create an undesirable negative reaction among certain sections of society.

This highlights the potential for art to be used as a means of communicating a scientific message and the challenges involved in doing this and still creating a work of art that has its own artistic merits. Nature (2021) highlights how there has been an increase in scientists working with artists, with nearly 40 % in their study stating they had worked with artists before and nearly the entire sample saying they would consider doing so in the future. This has been especially true in regard to environmental issues, and a good example can be provided by Brunel University London (2020), whose artwork entitled "catching a wave" is intended to raise awareness of coastal sustainability focusing on 5 selected sustainable development goals. "Vanishing point: Unseen" created by the University of Tasmania (2019) focuses on the danger of microplastics in the marine environment. Another example is "GYRE: The Plastic Ocean" (Plastic Pollution Coalition, 2014), a collaboration between marine scientists and artists. "Polar Zero", a climate science-art collaboration created by the British Antarctic Survey (2021), is an art project that created a sculpture containing air trapped in ice from 1765, intended to communicate humanity's ability to achieve progress and the consequences this progress creates. There has been an increase in art-science collaboration, especially in covering environmental topics. This has taken numerous forms from music projects, films, sculptures, and paintings. This highlights the role art could potentially play in helping address the issue of plastic pollution.

Staples et al. (2019) highlight the growing trend of art-based environmental education, with some studies suggesting that children in particular benefit from art-based education about the environment, with it being linked to increased levels of environmental concern (Reinsborough, 2008; Savva et al., 2004), as well as other aspects such as increased educational attainment and critical thinking skills. However, there appears to be a lack of evidence in the literature that it has proven to be effective at bringing about actual changes to behaviour and the number of studies that actually investigate this is limited. While art-science collaboration is often credited with producing changes in perspectives, methods to measure the actual impact this creates need further development (Paterson et al., 2020). The study conducted by Staples et al. (2019) concluded that the inclusion of art in environmental education was no more likely to enhance the children's environmental awareness. Their conclusion is that although art has considerable potential to help communicate an environmental message, it may fail to do so.

Some case studies, such as the work discussed in Curtis (2006), highlight that art has the ability to encourage viewers to reflect on their own behaviour and actions, however, there is a lack of research that actually assesses the ability of art to encourage behavioural change or increased levels of knowledge. Studies such as Curtis (2006) provide a snapshot of how the viewer felt whilst viewing the artwork, which may not lead to any meaningful change. This same issue is found in Song (2017), who investigated the effectiveness of plastic bag based art as a means of communicating an environmental message. Despite finding that participants were likely to say the activity increased their awareness of the issues, there is no effort in the study to measure if they influenced changes in behaviour or became more knowledgeable, and this is common in the previous studies. This highlights a gap in the research that needs to be addressed.

1.2. Study concept, rationale and objectives

In 2019/2020, the TRACE (Transitioning to a Circular Economy) with artists project, a novel and ground-breaking collaboration between scientists, creative artists, and primary schoolchildren, was devised and delivered (Brock et al., 2022). The concept that underpinned TRACE is that *combining intergenerational influence and the skills of creative artists enables enhanced public communication of scientific/engineering principles and that this can facilitate behaviour change* (COM-ART).

Intergenerational influence occurs in a setting where one generation has a positive influence on the behaviour of another (Maddox *et al.*, 2011). The aim of TRACE was to trial and critically review the capability of COM-ART to communicate to the public about e-waste to stimulate behaviour change towards circular economy principles. The project was very successful, and was nominated and shortlisted for a global award (ISWA Communication Award) and won a 2021 UK National Recycling Award (Communication Campaign).

This study (Transitioning to a circular economy for plastics with an artist in residence; “TRACE-P”) aimed to further develop this new approach by partnering academics with an artist in residence to raise awareness, provide inspiration and promote behaviour change relating to plastic waste. It aimed to assess the impact of combining intergenerational influence with art to raise awareness of plastic pollution, and its potential to create behavioural change following exposure to carefully designed artworks. In this case, intergenerational influence occurs in settings where children’s instinctive reactions to creation/display of artworks influences adults. This is because children’s ideas for, and instinctive reactions to, artworks displaying plastic pollution can prompt emotional responses in adults that catalyse behaviour change, policy support (Reinsborough, 2008; Savva *et al.*, 2004), and social norms favouring reduced plastic use and circular design. Intergenerational art projects bridge science and creativity, showing risks and solutions, empowering children and influencing caregivers and policymakers to back recycling, reuse and redesign. Case studies show creative education and intergenerational engagement accelerate public acceptance of circular plastics policies and infrastructure and corporate responsibility broadly (e.g. UNICEF, 2024).

The objectives were to:

- Highlight the potential for art to be used as a means of communicating a scientific message and critically discuss the inherent challenges (see above).
- Partner an artist-in-residence with specialist academics and children to discuss academic evidence and professional experience relating to the environmental, socio-economic, and technical challenges of waste (plastic) management.
- Develop artworks and then assess the success of these in raising awareness of plastic pollution.
- Create recommendations for how artwork could be used more effectively in the future for generating awareness of environmental issues and supporting public policies and strategies.

2. Methods

TRACE-P had four major phases: i) literature review (see Section 1) ii) discussions between the artist-in-residence and specialist academics; iii) creation and exhibition of artwork, including with children; and iv) design of questionnaire, public survey and data analysis.

2.1. Subject discussions

The external partner providing specialist creative skills and appointed as artist-in-residence was [Susannah Pal](#). Pal is a painter who is interested in human behaviour. The TRACE project allowed her to delve into the complexities of questioning why people make environmentally conscious choices. In it, she reflected on whether these choices stem from a desire to appear morally good or if they are truly motivated by impactful change, and if it matters. Pal was interested in how we can think critically about the actions that would genuinely make a difference in addressing environmental issues.

The artist had many detailed discussions during November 2021–May 2022 with specialist researchers from the University of Southampton’s Faculties of Engineering and Physical Sciences (FEPS) and Environment and Life Sciences (FELS) about plastic waste management principles, practices & operations, socio-economic, health &

environmental impacts. This enabled the artist to secure a contemporary, evidence-based understanding of the global consequences of plastic waste to stimulate creative thoughts and delivery of artwork. The research that underpinned the discussions focused on landfill engineering and pollution control, waste and resource management in urban environments, and plastic waste and its impacts in the environment.

Other professional contributors to the discussions included officers from the Environment Agency (via their leadership of the [Preventing Plastic Pollution](#) campaign), [Suez Environmental](#), the [John Hansard Gallery](#), the [University’s Estates & Facilities team](#), the [Chartered Institution of Wastes Management \(CIWM\)](#), and academics from other universities in the south of England. The University of Southampton’s [Centre for Doctoral Training in Sustainable Infrastructure Systems](#) sponsored a PhD student (Roberts) to enable successful delivery and evaluation of this project.

Discussions between the artist and the extensive range of academics and waste professionals were not audio or video recorded, were led by the artist to fill her knowledge gaps and follow her artistic instincts. The discussions were open-ended. She recorded the information in her own way and often then translated the knowledge shared into ideas and sketches for artwork into her personal sketchpads that she used to support the project.

2.2. Creation and exhibition of artwork

The second phase, which overlapped to some extent with the first phase of work, involved the generation, communication, and exhibition of artwork created by the artist-in-residence. Pal’s role as an artist was to take academic research and translate it into emotionally challenging artwork that provoked dialogue and inspired action. Pal selected a tragicomic genre for her art because tragicomic artworks blend humour and sorrow to engage audiences without overwhelming them. Comedy can lower defences while tragedy conveys harm, making plastic pollution relatable and memorable. This tonal mix can prompt reflection, reduces denial, and motivates collective action toward reuse, redesign, and policy support, easing the emotional barrier to embracing circular-economy solutions.

In addition to the creation of artwork, other activities were designed and delivered to raise awareness of plastic pollution via the medium of art. These included:

- Production and delivery of two public art exhibitions.
- A plastic pollution and online drawing workshop event.
- A workshop event at a local art gallery.
- Involvement of children.
- Production and display of two short bespoke films.
- Production of postcards of the artwork.
- Social media and a blog.

During TRACE in 2020 ([Brock *et al.*, 2022](#)), a film documenting the project was produced that included Pal’s work (<https://www.youtube.com/watch?v=duDdWq8BZE>). It was a powerful tool in showcasing the work and helped the study stand out at the 2021 National Recycling Awards. Thus we decided to make two short films. To make the films, we secured the services of award-winning documentary producer Alice Fraser (Thatcher BBC, Holocaust Denial BBC, First Ladies CNN). Fraser interviewed Pal prior to the filming to understand the aims and objectives of the TRACE-P project as well as what she was learning and making. She then teased out the most concise way of showing the ideas behind the art. Fraser has a wealth of experience working with scientists and historians so understands how to take complex information and make it into a digestible story for a public audience. The short films aimed to demystify the issues. They helped to guide and encourage viewers to consider their own relationship to the plastic in their lives.

2.3. Survey design

To capture the responses and engagement of the public with the TRACE-P activities and performances various social research methods were employed. They were:

- Surveys: the questionnaire contained three sections, of which people were asked to only complete one section. These were for those who have not yet seen the artwork, for those who saw it shortly before completing the survey, and those who saw it more than one month ago. The first section allows a baseline to be created before exposure to the artwork. The second measured the immediate impact of the artwork. The final section assessed whether exposure led to any changes in behaviour and perceptions after one month.
- Qualitative data analysis for the open questions in the questionnaire, analysed using thematic analysis to identify key themes that emerge from the data.
- Post-it note boards with questions relating to the artwork during the exhibition.
- Social media engagement was analysed based on 'likes' and 'retweets' of posts related to the TRACE-P project put out by the social media channels related to the project.

Respondents to the survey were those who attended TRACE-P activities and performances; no demographic information was collected. The surveys yielded the six themes (shown later in Fig. 2) via qualitative coding (Vaughn and Turner, 2015). Themes can guide targeted education, design interventions, and inclusive circular-economy policies by linking public sentiment to actionable system changes. The survey questions about reducing plastic consumption and reusing or recycling items aimed to shed light on the potential operationalization of circular-economy principles by measuring behaviours, barriers, motivations, and support for systemic change. We anticipated that responses could identify e.g. potential for demand reduction, reuse adoption, and collection/reprocessing gaps, informing policy, design and infrastructure to keep materials in use. In terms of the generalisability of this approach, such surveys can track progress, reveal equity and access issues, and guide targeted interventions linking individual actions to broader circular strategies and enable monitoring of circular metrics, stakeholder engagement, and resource efficiency outcomes.

3. Results

3.1. Public engagement with artworks

The artist-in-residence immersed herself in waste management research and problems. As well as weekly meetings with the project lead, she interviewed a range of scientists and waste management professionals. She learned how art has been impactful in communicating complex problems and then changing public opinion. A key finding was that the best way is to encourage viewers to reflect on their own relationship with their 'stuff'. So that the art did not rely on propaganda, the artist-in-residence produced art to reflect on her own heavy consumerism as a child of 1990s growing up in a world where throwaway plastic was the norm. She created art that illustrates the impact such behaviour has on the environment, e.g. showing how nano-plastics and micro-plastics enter the food chain through fish and via sewage sludge deposited on agricultural land.

Pal particularly observed that there is a lack of awareness that the actions and inactions of what people do with their plastic waste can slow or even stop the circular economy from working. This is especially true of on-the-go plastics (bottles and soft packaging). She produced a body of work – a total of 13 pictures (see Appendix 1) - that portrayed relatable leisure scenes on the coast. Pal invited viewers to empathise with their plastic wastes by generating artwork that portrays them with an anthropomorphic and organic feel. Although human action was at the

forefront of the visual narratives, the detrimental effects of micro plastic and macro plastic featured in subtle ways. For example, crabs caught in fishing nets. The drawings/paintings are from a tragicomedy genre.

Two public art exhibitions were successfully generated and delivered (Fig. 1a and b). The artworks were first displayed on the May 7, 2022 at Southampton Science and Engineering (SoTSEF) week on the university's Boldrewood campus. Several thousand people attended the SoTSEF event, predominantly with children, with most spending some time at the exhibition. Art is always open to interpretation and our intention was not to dictate or preach at the viewer but to gently provoke reflection. The artist and co-authors were present to provide explanations, and physical (paper) literature helped viewers to understand the art. A second exhibition took place at The Crypt Gallery in Euston, London. during 4–7 July 2022, with several hundred people attending.

A plastic pollution and drawing workshop event at Highfield Campus, University of Southampton, was successfully generated and delivered on March 16, 2022 (Fig. 1c). The event drew both an in-person and online audience, with people joining from as far afield as Germany. The audience reported both enjoying the event and learning a great deal about the impacts of microplastics on the environment. Examples of art drawn by participants is shown in Fig. 1b. A similar workshop event was successfully delivered at the John Hansard Gallery on March 31, 2022 (Appendix 2). Postcards depicting the artwork were produced and widely distributed. An example blog is shown in Appendix 3.

Two short films were successfully designed and produced:

- A 5 min looped film for the John Hansard Gallery that helped to explain the artistic process and how it connects to the work of, and messages provided by academic and operational professionals who have worked on pollution from plastic waste.
- An animated film ("The Sapien, The Wasp and The Teeny Tiny Plastics") that was shown during the two public art exhibitions in 2022 (<https://youtu.be/KGLcMc6ZrYk>).

3.2. Social survey

The ranking of environmental issues by respondents is shown in Table 1. This highlights climate change as the number one issue, followed by loss of biodiversity and rainforest destruction, which had very similar scores (101 and 100). Marine plastic pollution was ranked 4th, followed by air pollution from vehicles and the e-waste crisis.

The levels of respondent agreement with various statements relating to plastic waste/pollution are summarised in Table 2. Respondents' views on statements relating to single-use plastics are summarised in Table 3; every respondent reported that they "intend to consciously reduce single-use plastic usage in the future." In comparison, 80 % of respondents reported that they "intend to consciously reduce non-single-use plastic usage in the future"; however, when asked to specify examples, the vast majority of the examples given were actually single-use plastics.

Four consistent themes emerged from the question, "Did you relate to any of the topics, scenes or characters presented in the artwork?" They were "difficult choices", "the inevitability of pollution in the modern world", "lack of awareness" and "hypocrite". Respondents felt that the artwork highlighted how it is often difficult to weigh up the different options and make the right choices, such as selecting between plastic bags with a lower carbon cost or cotton bags without the risk of plastic pollution. Many felt that pollution was inevitable in the modern world and that no matter what they chose to do, they would still be polluting in some way. Respondents mentioned how they were unaware of various ways plastic pollution can be created, such as tyre wear from vehicles, including electric vehicles. This was the topic of one of the artworks and it was reflected in many of the responses. Many mentioned feeling like hypocrites for their actions towards the environment, or their feelings towards the woman depicted in the artwork.

Three groups of respondents emerged from the question, "Will you



My Plastic World

An exhibition of 13 works on paper by Susannah Pal inspired by the research of The Waste Management Research Group.

Science and Engineering Day
10:30 - 16:30, Saturday 7th May 2022
Building B175, Boldwood Campus, The University of Southampton

“Transitioning to a Circular Economy with Creative Artists - Plastic Pollution” is a collaboration between Professor Ian Williams at the University of Southampton and Artist Susannah Pal.
Scan the QR code to book your ticket for the day and to learn more about the project.
@envirostaff
www.susannahpal.com @susannahpalartist @envirostaff

Funded by the Engineering and Physical Sciences Research Council via the University of Southampton's Impact Acceleration Account 2021 and its Centre for Doctoral Training in Sustainable Infrastructure Systems (EP/L015826/1).

BRITISH SCIENCE WEEK
University of Southampton

The Wind It Stole My Balloon' by Susannah Pal. Ink, Watercolour, Gouache and Coloured Pencil on paper, 59 x 59 cm. copyright © Susannah Pal

a)



EXHIBITION
The Otherwise Good Person by Susannah Pal
4 Jul 2022 - 7 Jul 2022

Times and details ^

Regular hours Free admission

Mon, 04 Jul	15:00 - 20:00
Tue, 05 Jul	12:00 - 20:00
Wed, 06 Jul	12:00 - 20:00
Thu, 07 Jul	12:00 - 20:00

The Crypt Gallery - St Pancras Church 
London, United Kingdom

b)



SOUTHAMPTON SCIENCE AND ENGINEERING FESTIVAL 

Explore an Object You Own and Learn about Plastic Pollution
Drawing Workshop with Susannah Pal

● FREE | ONLINE | LIVE EVENT

Wednesday 16 March 2022
18:00 - 19:00 GMT (UTC)

Visit bit.ly/UoSExploreAnObject #SOTSEF

c)

Fig. 1. a and b) Advertisements for the two public art exhibitions generated and delivered for the TRACE-P project by Susannah Pal; c) Advertisement for a plastic pollution and drawing workshop event delivered for the TRACE-P project and two examples of artwork produced by participants.

take any actions as a result of viewing this artwork?” They were those who said they would “make no change”, those who wanted to “educate themselves and others”, and those who wanted to “reduce single-use plastics”. The “no change” group said they felt they were already doing everything they could, and they were often people who had been very engaged with reducing their plastic pollution already, rather than people who did not care.

Six themes emerged from the question “Do you have any further comments about how this artwork made you feel?” (Fig. 2). Some respondents associated the artwork with religion, and felt it made them reflect on spirituality. An impending sense of doom was reported by

many respondents, who felt the problem of plastic pollution was only going to get worse and bring severe consequences. Many respondents stated a desire to protect nature more, reflecting that modern lifestyles were inevitably going to lead to pollution and needed to be questioned. A similar theme was the unintended impact of commonplace modern activities, such as driving a car and hence producing plastic pollution through tyre wear. In terms of the artwork and drawings created, many commented on artwork that involved identifiable objects that appeared to carry greater meaning, such as a Lego figure or a Little Mermaid figure.

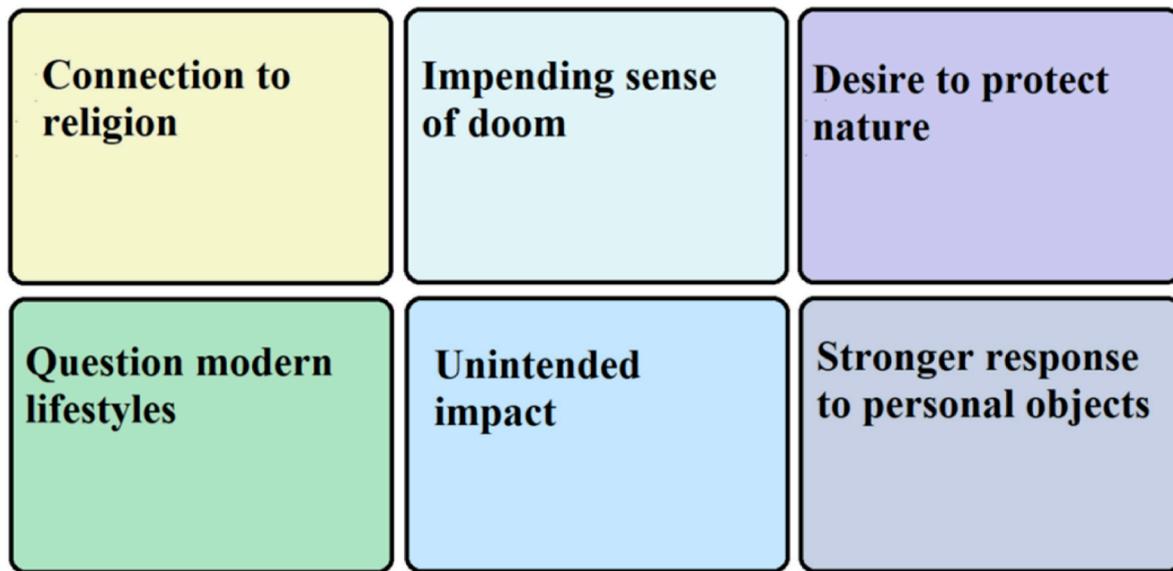


Fig. 2. Themes emerging from the question “Do you have any further comments about how this artwork made you feel?”

Table 1

Respondents’ ranking of environmental issues based on importance. (Ranking achieved by awarding 1 point for last place, then 2, 3, 4, 5 and 6 for first place, then totalling).

Issue	Ranking	Score
Climate change	1	130 (25 %)
Loss of biodiversity	2	101 (19 %)
Rainforest destruction	3	100 (19 %)
Marine plastic pollution	4	87 (17 %)
Air pollution from vehicles	5	62 (12 %)
E-waste crisis	6	40 (8 %)

4. Discussion

The concise review in Section 1 underlines that art has considerable theoretical potential to be utilised as a channel for communicating a scientific message whilst demonstrating the current lack of evidence that artworks have had a clear impact on policy, society, and behaviour change beyond its proven use for propaganda purposes under specific circumstances. The involvement of children can enhance the emotional impact of artworks, leading to increased levels of environmental awareness.

Discussions with waste specialists enabled the artist-in-residence to secure a contemporary, evidence-based understanding of the global consequences of plastic waste. Artwork was subsequently produced in a tragicomedy genre that portrayed relatable leisure scenes on the coast, illustrating consumerism in a world where throwaway plastic is the norm. The artworks were displayed to enthralled audiences via public exhibitions, videos, social media and distributed using postcards. In-person and online plastic pollution themed workshop events generated interest, enjoyment, and education on the impacts of microplastics on the environment. The artworks were clearly very successful in encouraging viewers to reflect on their own relationship with their belongings and the impact of their consumerist behaviour on the environment. Indeed, prints of the artwork have subsequently sold well to public bodies and private collectors.

The survey results consistently show that respondents consider plastic pollution to be a serious issue, agree that action should be taken to reduce it, and would be willing to adjust their lifestyles in order to do this. However, these views do not necessarily relate to current actions, with just under half of the respondents only choosing to reduce single-use plastics sometimes or rarely, very few choosing to do so always.

This highlights potential for considerable improvements, and all respondents reported intending to reduce future single-use plastics usage in the future.

Respondents reported being much less likely to avoid purchasing non-single use plastics, highlighting a clear difference in the attitude towards single-use and non-single use plastics. The majority stated they would reduce non-single use plastic usage in the future, although when asked to provide examples, the majority provided were single-use plastics. Yet most respondents were confident they know the difference between single-use and non-single-use plastics, highlighting respondents’ overconfidence in their classifying skills and lack of correct knowledge.

In terms of reactions to the artwork, the vast majority reported that seeing the artwork has made them want to take action to reduce plastic pollution. Without follow-up data, which is impossible to collect from a transient audience, it is difficult to know how well this translates into future action. However, Liu et al. (2020) highlighted a link between environmental knowledge and pro-environmental behaviours, although this link is not as direct and clear as it could be, and progress needs to be made in this area. This attitude-intention-behaviour gap discussed by authors such as El Haffar et al. (2020) is a key issue, however art is an underexplored approach to this issue, and the emotional responses created by artwork may produce improved results. The emotional, and sometimes spiritual feelings created by the artwork presented in the qualitative results highlights the ability of art to create responses that other approaches may not be able to. Considering that responses about single and multi-use plastics highlight a lack of correct knowledge, improving environmental knowledge has value in itself, as at least it should better enable the participants to correctly identify single-use plastics, which they have shown a desire to reduce. The responses are also useful in identifying which environmental issues matter most to the viewers, which is useful when designing future studies or approaches.

The respondents were divided on whether or not the artwork made them feel powerless to reduce plastic pollution. This may be because many respondents recorded learning about new sources of plastic pollution, such as tyre wear and shedding from acrylic clothing, which made them feel plastic pollution is inevitable. Many mentioned that the artwork made them feel that it is hard to make the right choices, and no matter what choice they make there is always a negative impact. The respondents also frequently mentioned either not being aware of many of the pollution sources shown in the artworks, or feeling like hypocrites for knowing about the impact of plastic but not taking enough action.

Table 2
 Respondents' agreement with various statements relating to plastic waste/pollution. (Note values do not always total 100 % due to non-responses in some categories).

Statement provided to respondents	% of respondents in each category				
	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Plastic pollution is a serious issue	72	24	–	–	4
The most environmentally friendly packaging should always be used	60	36	–	–	4
I would be willing to change my lifestyle to reduce plastic	56	28	12	–	4
I am confident I dispose of plastic correctly	8	40	28	16	8
I would choose to reduce my plastic usage even if it was more expensive or less convenient for me personally	24	56	8	8	4
It is possible to reduce my plastic usage and still enjoy a quality of life that is the same or better	24	52	8	8	4
Do you feel seeing the art exhibition has made you want to take action to reduce plastic pollution?	12	80	8	–	–
Do you feel seeing the art exhibition has made you feel powerless to reduce plastic pollution?"	8	28	16	44	4
I am aware of the difference between single-use plastics and multiple-use plastics	28	52	12	–	8
I feel knowledgeable enough about plastic pollution to adjust my lifestyle accordingly	8	64	16	4	8

Table 3
 Respondents' agreement with statements relating to single-use plastics.

Statement provided to respondents	% of respondents in each category				
	Never	Rarely	Sometimes	Often	Always
In the last month, how many times have you tried to consciously avoid using single-use plastic unnecessarily?	–	8	36	48	8
In the last month, how many times have you tried to consciously avoid purchasing non-single use objects made from plastic?	20	24	32	24	–

This shows that the artwork was successful in communicating the moral dilemmas faced by people trying to reduce their environmental impact, as well as educating people about a range of sources of plastic pollution.

Two clear actions people said they would take in response to the artwork were to focus on educating themselves and others, and/or reducing their single-use plastic usage.

Creative artists translating scientific and engineering insights about plastic waste into visceral, public-facing artworks reveal a policy gap: when legislation and formal communication fail to motivate systemic change, society can sometimes rely on art to make harms visible and urgent. Emphasis on the responsibility of the consumer of disposable items “obscures the responsibility of industry and governments in overproduction, planned obsolescence and inadequate disposal of plastics” (Chertkovskaya et al., 2020). This reliance signals inadequate policy delivery, enforcement, or public engagement and highlights missed opportunities for upstream regulation and circular design (Chertkovskaya et al., 2020; Winters, 2025).

Measuring sustained shifts toward a circular plastics economy is difficult because initial engagement and intentions often decay, self-report surveys overestimate real action, and short follow-up windows miss relapses and context-driven behaviour (seasonal, economic, infrastructural) (MacDonald et al., 2023). Robust evidence requires longitudinal intervention studies with control or comparison groups, objective outcomes such as waste audits, purchase or municipal collection data, and mixed methods to capture motivations and barriers. Trials must run long enough to observe habit formation and system responses, disaggregate impacts by socioeconomic group, and assess policy and infrastructure interactions that enable or block sustained reuse, repair, and recycling.

Nevertheless, our results show that the artwork successfully communicated a message and created a desire among viewers to protect the environment, question the impact(s) of their lifestyles and an ambition to reduce this impact. The artwork that had the biggest impact on people appears to be that which focused on non-single-use objects, with many respondents mentioning objects such as the Lego figures.

5. Conclusions

This study has demonstrated that the COM-ART concept has considerable potential as an approach to improve scientific communication and stimulate change based on scientific evidence. The TRACE-P project has effectively demonstrated that bespoke artworks can raise awareness of plastic wastes and their consequences, facilitate self-reflection on consumption behaviour, and successfully initiate behavioural change. The study reinforces the nascent evidence-base that both quantitative and qualitative methods are required to solve complex human-environment interactions.

The carefully designed artwork was successful in: i) educating people about sources and impacts of plastic pollution ii) creating an emotional response from viewers iii) encouraging people to reduce their plastic usage and question the impact their lifestyles have on the environment. Reducing single-use plastics appears to be the most desired behaviour change.

Whilst not the focus of our study, we have concluded that art-science collaborations may be optimised by following some simple rules. Co-design from the first meeting. Define clear, shared goals. Agree timelines and deliverables. Respect each other's methods. Assign roles and decision rights. Secure stable funding and resources. Prototype quickly and test publicly. Evaluate outcomes with simple metrics. Involve affected communities early. Protect and clarify intellectual property and credit. Plan for policy and public dissemination. Build routes to scale successful ideas. Following these straightforward rules reduces potential for disputes and operational error and makes the whole activity smooth and readily deliverable.”

Universities' research projects often successfully deliver progressive scientific, technological, regulatory, and social-economic outcomes. Nevertheless, the rate of change towards sustainable waste management and progress on systems for the development of a circular economy remains leisurely, especially for plastic wastes. Hastening the impact of

research locally, nationally, and internationally raises awareness of its outputs/outcomes and supports civic- and sustainability-related agendas. It reinforces relationships between universities with partners such as local authorities, regulatory bodies, public and private sector waste management organisations, and arts venues, by supporting their work and facilitating successful delivery of ongoing activities. TRACE-P has provided an exemplar concept for how partnership with artists may inspire the public to speed up translation of scientific and engineering ideas/outputs based on circular economy principles into behaviour change for a low carbon, low plastic wastes, resource efficient and sustainable future.

CRedit authorship contribution statement

I.D. Williams: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **T.J. Roberts:** Writing – review & editing, Writing – original draft, Investigation, Formal analysis, Data curation.

Ethical approval and informed consent statements

This study was approved by the University of Southampton Research Ethics Committee (approval no. ERGO II 72348XYZ123) on May 06, 2022.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jclepro.2025.147261>.

Data availability

Data will be made available on request.

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