# Revitalizing Environmental DIY Science Workshops for Studio Austen


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**May 2022**

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# TABLE OF CONTENTS


1. Title Page 01
2. Table of Contents 02
3. Abstract 03
4. Introduction 04-05
5. Background 06-09
6. Methods & Sponsor Overview 10
7. Objectives 11-13
8. Results 14-21
9. Conclusions & Recommendations 22-23
9. References 24-50

# ABSTRACT

The general public has few opportunities to engage in meaningful scientific research outside of specialized labs. To engage citizens in the process of knowledge production, many studios and public research centers have started using DIY science. These studios combine DIY science with participatory action research to collect large amounts of data in a short period of time by using citizens to perform the experiments. For this project, our team revitalized protocols for DIY workshops that our sponsor, Studio Austen, holds for the general public. Our research involved using the principles of technical writing to compose new protocols, optimizing the display methods of our workshop templates, analyzing the accessibility and cost of workshop materials, and implementing an online survey system for participants to provide feedback on how to improve the protocols in the future. From our research and the information given from our sponsor, our team used step by step instructions with pictures on the side to simplify how to perform the workshops. For the display of the protocols, our team utilized a graphic design platform called Canva. To display our protocols we were able to create a bifold template that is visually appealing to the audience. Studio Austen already employed inexpensive materials, but we were able to identify a cost reduction on one workshop. Finally, we used an online survey platform called Epicollect5 to create a survey accessed by a QR code. With these improvements, we hope that Studio Austen will be able to encourage a relationship between the public and the environment that is based on accountability and awareness. Through the feedback system we created, Studio Austen will be able to gauge the impact that this project had on its workshop protocols.

## DIY SCIENCE: A MORE INCLUSIVE WAY OF LEARNING

Environmental scientific research predominantly occurs in specialized labs with scientists with advanced degrees. These fields have been broadly considered too specialized because of these aspects, and are inaccessible to the general public[1]. Meanwhile, there are major global concerns with environmental sustainability and climate change that are being addressed through large corporate projects that require vast resources[2]. These resources include large scientific laboratories, expensive scientific equipment, and years of schooling to gain the knowledge on how to partake in the research. These factors can make it difficult for the public to participate in research within conventional science, and the exclusivity of the research process fails to involve the public in a process that is being conducted for its benefit.

DIY science can be a more inclusive method of research, particularly when combined with participatory action research, it provides a wonderful opportunity to allow everyday people to be included in the research on the environment. DIY science, also known as do-it-yourself science, is a biotechnological social movement in which individuals, communities, and small organizations study life sciences using similar methods as traditional research institutions, while taking inclusivity and common accessibility of materials into account. This science poses a powerful way of educating the public because of its understandability and its effectiveness. DIY workshops on microplastics within the surrounding environment are a good example of DIY science research meant to solve the ramifications of people's everyday lives while including the public in the research. These can include searching for microplastics in fish guts, plant matter, and even in the air.

Nowadays there are studies that have found microplastics within 80% people's bloodstreams, which amplifies the fact that large environmental issues can even come to a point in which they affect people's healths, and workshops like these can help raise awareness to these newly found issues[3]. The infographic below portrays the microplastics within the environment:

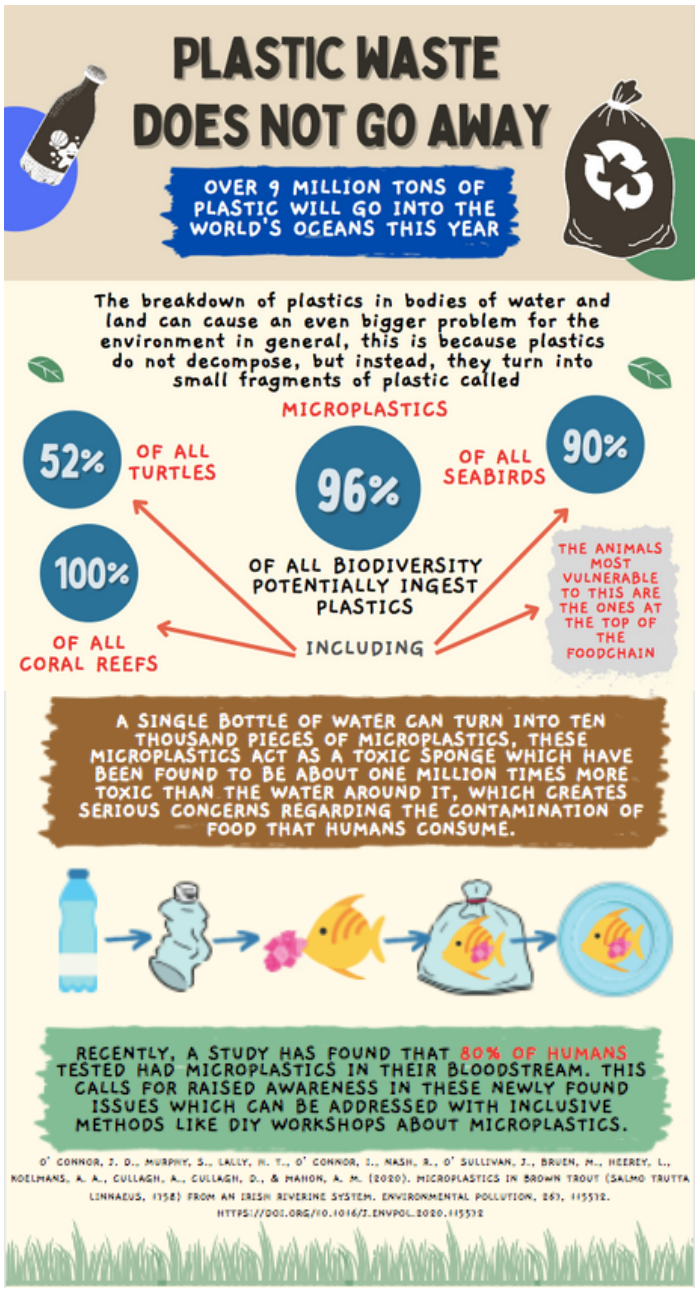



Figure 1: Microplastics Infographic

# INTRODUCTION

DIY science doesn't need to be in any professional setting. It can be within any participant's own home. DIY science that addresses environmental issues allows for the democratization of science by challenging the corporate model and allowing interested individuals to engage in scientific endeavors through a variety of pathways, from community laboratories to tinkering in garages[4]. Because of its simplicity and accessibility, DIY science has been growing over the past few years[5], while research by large corporations has been continually reducing[6]. This is indicated in Figure 2. DIY science can be combined with participatory action research to enhance its performance and provide an inclusive alternative to the declining conventional science research methods. Participatory action research "is research by, with, and for people affected by a particular problem, which takes place in collaboration with academic researchers.[7] This causes the participants to want to partake in action in reversing environmental concerns. This is because before participating, the participants may have an uncertainty about the accuracy of their knowledge.

However, after experiencing and learning first hand, the participant knows the entirety of the problem and will want to reverse that problem as much as they can[8]. Studio Austen, a research enterprise at the intersection of art and science, has the mission of promoting a future that is more environmentally and socially just. Studio Austen incorporates all of these methods within the many DIY science workshops that the studio has designed to spread environmental awareness. Our project goal was to research the best display methods and formats for each intended workshop audience to create a set of templates that could house any of our sponsor's DIY workshop protocols. During the project, our team performed DIY workshops with Kat austen to write the protocols in a user friendly format. We also improved the accessibility of the workshops by utilizing an online database that stored all of the new and improved protocols. Finally, we implemented an online feedback system to allow Studio Austen to continue improving their protocols after the project was finished.

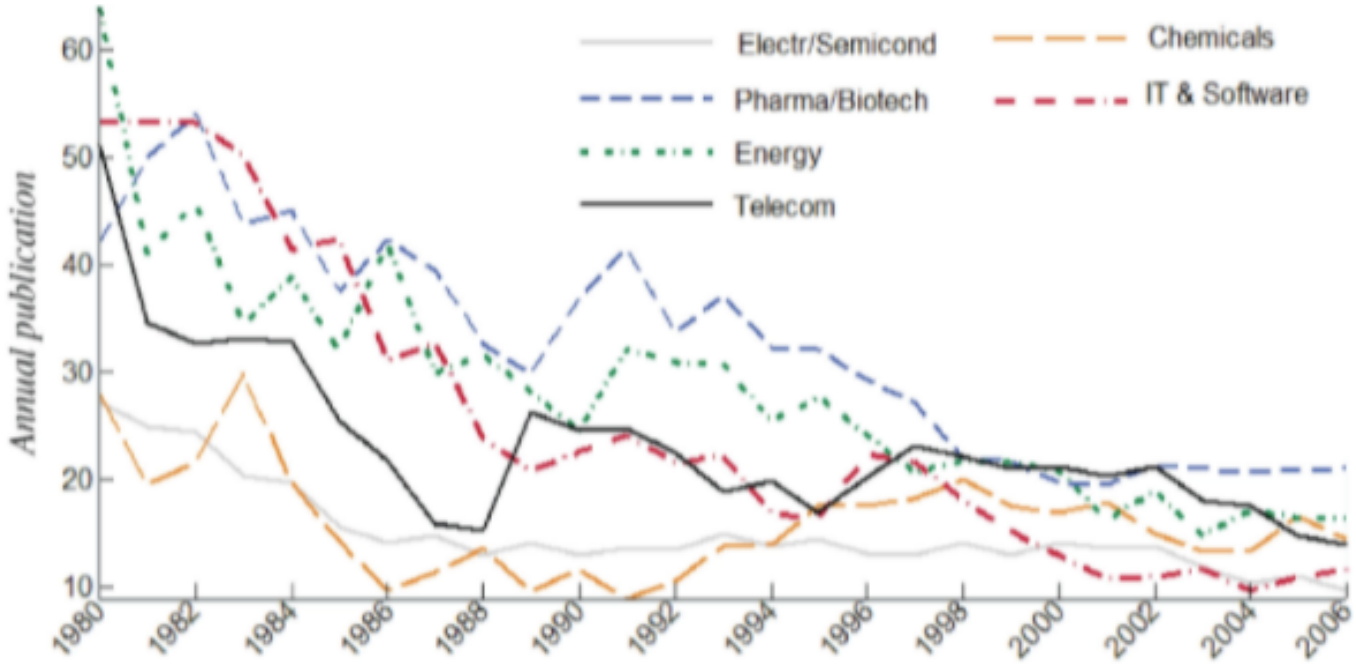



Figure 2: This figure represents the publications of research annually based on its selected industry[6](Arora, Belenzon, and Patacconi 2018).

## AN INCLUSIVE APPROACH TO SCIENTIFIC RESEARCH: HEALING THE PLANET LITTLE BY LITTLE

We are aware of the steps that governments, corporations, and universities with the use of conventional science are taking to address global environmental problems: but where does that leave the non-specialists? The steps taken by these entities are extremely exclusive. The average person would never be able to participate due to either lack of experience, resources, and/or knowledge. Public concern for the environment suffers from the general public being insufficiently involved in the production of environmental knowledge. There are other forms of science, on the other hand, that represent more inclusive approaches to investigating the ramifications of environmental problems that affect people's everyday lives. Combined with participatory research methods, they can be a helpful way to connect the environment, art, and society while gathering feedback directly from participants.

The public's involvement in research is hindered by the cost, transparency, and accessibility of conventional scientific research and its required materials and processes. The lack of accessibility and high cost go hand in hand, since the majority of the equipment and space is too expensive for the average person. On average, it costs around $756 per square foot to build a laboratory. If this is compared to a school, it would be on average over $400 more per square foot[9]. Not only are the materials and space expensive, but most professional laboratories require a scientist to have earned at least a bachelor's degree, and in many cases, a graduate's degree. On top of the investment of time, it also averages a cost of $19,324 per year in Germany[10]. These features require a significant investment of time, effort and money.

Open science, DIY Science and citizen science are more inclusive approaches to scientific practice. Open science "encompasses unhindered access to scientific articles, access to data from public research, and collaborative research enabled by ICT [Information and communication technologies] tools and incentives"[11]. Citizen science is a method of open science that deploys members of the general public to collect and sometimes analyze data[12]. This form of science allows the lay person to participate and learn firsthand what they are researching. DIY science is another method of open science in which a lay person performs scientific research with simple and inexpensive means. DIY science teaches the basis for a certain topic and the logical path to find a solution through affordable means. One example of DIY science involves the construction of microscopes. A conventional microscope costs between $5,000 and $10,000 whereas an operational DIY microscope just as precise can be made out of 3D printed parts and Legos at a cost of around $300[13].

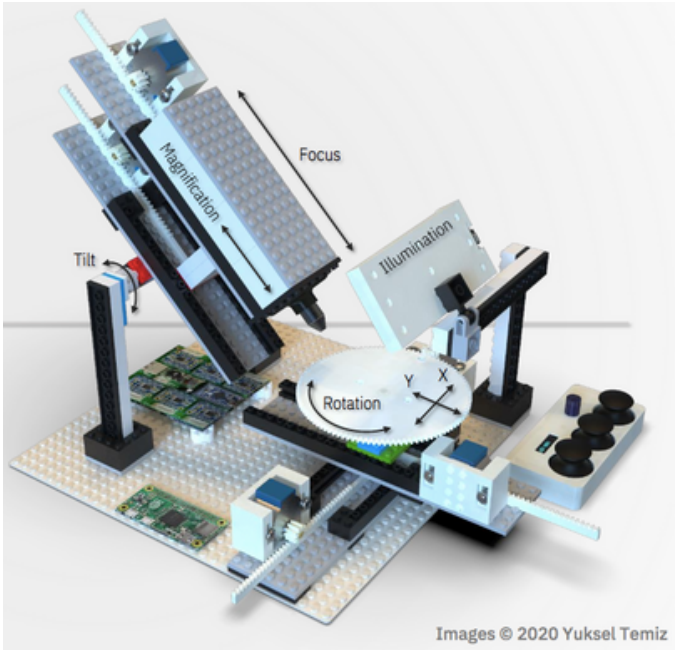



Figure 3: Lego Microscope

# BACKGROUND

Open Science approaches help scientists gain larger amounts of data and participants of much wider age ranges can gain experience and awareness on environmental issues. “Citizen science is also growing quickly, given its potential to enhance knowledge production by diverse participants, generating large and global data sets”[14]. The public involvement in science has allowed researchers to collect large-scale and real-time data and also engage citizens, so researchers are adopting citizen science in many areas. DIY Science is a practice that can be used to attract and connect with children to expose them to adapting positive environmental ideas and actions from an earlier age, as well as help people of older audiences become aware of how close to home the effects of today’s environmental issues can be.

When it comes to corporate environmental science research, the lay person tends to not fully understand some of the concepts presented due to how exclusive the research is, which can affect the impact that this type of research is supposed to invoke on the public. Noel Gough, a Foundation Professor of Outdoor and Environmental Education, claims that “pursuing environmental education research as a ‘science’ produces blind spots that might be illuminated by deliberately deploying strategies and perspectives drawn from contemporary art and popular media”[15]. To further this point, the data from conventional scientific research communicates complex data, and requires political, social, and economic skills beyond conventional disciplinary expertise. Because conventional research struggles to communicate complex problems and findings to the public, a more inclusive, relatable, and understandable approach should be taken when addressing an issue like the environment. Participatory action research that utilizes DIY science is a solution to the exclusive approach of conventional science. Participatory action research uses iterative methods that focus on involving the general public in the research itself. This is accomplished both through participating in the research as well as the main researcher observing and recording the public reactions. This research method uses an iterative process where the researcher collaborates with the community where they first evaluate the problem. Secondly, they plan on how to solve that problem. Then they act on the problem, putting their research into action. Next, they reflect on their research. Finally, they repeat the process until the research is


Figure 4: Iterative PAR cycles [16]

Participatory action research (PAR) is also a method centered on the study of social problems with the intent to take action to change them. Participatory action research is best described by the acronym below:

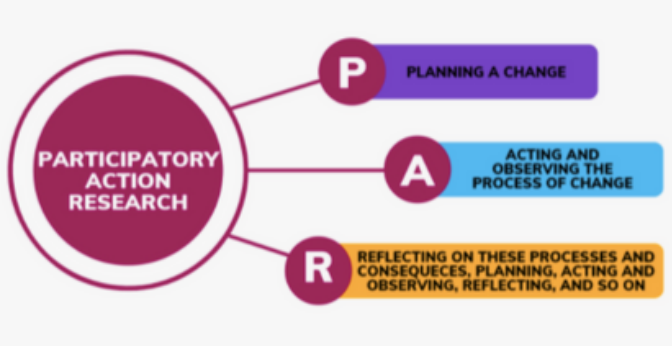



Figure 5: Participatory action research acronym graphic[17]

PAR allows the general public to participate in the research directly. This allows them to learn and understand the problem first hand as well as creating solutions that can fix the problem. It also allows the researcher and their stakeholders/constituents to all be equal partners. This includes identifying the research questions, the collection of data, and its analysis. This research is also the “pragmatic co-creation of knowing with, not on, people"[18].

This empowers the people while creating a democratic research project and allows the people to get direct knowledge of the problem by actively identifying the problem as well as pursuing the problem solving with the researcher, rather than just being told what is wrong.

PAR is doubly valuable in as much as it has a proven record of creating changes in policy. In the 1960s, researchers turned to participatory action after problems emerged in policies around poverty, environmental risks, social injustice, and public health and safety. One of these examples was the participatory action research conducted in Eastern Uganda. This research was to identify the "low utilization of maternal and neonatal health services, poverty, low male involvement in reproductive health issues, lack of transport to health facilities, geographical inaccessibility of health facilities, rude health workers, inadequate skills of health workers and managers, and frequent stock-outs of essential drugs and supplies in the health facilities"[19]. During This research, politicians, administrators, and health managers acted as the stakeholders and participants within the study. These participants utilized semi structured interviews and surveys to gather information from the community. After their participation, they stated that PAR challenged them "to be more reflective, responsible and accountable", as well as feeling "awakened and inspired"[19]. After this study, there were improvements to health management throughout Eastern Uganda.

DIY science and open science can be used as participatory research that can "Profoundly transform what we know"[20]. This form of science focuses on teaching the basics needed for a certain topic as well as providing a simple, logical path to help participants perform the DIY tasks provided. With its simplicity and its accessibility, larger amounts of data in research in much shorter periods of time compared to other scientific methods. It can help discover new problems as well as create solutions to those problems from the research being conducted by the general public. "Participatory research is not necessarily just 'science by other means', but could refocus what parts of the natural and social worlds are subject to scientific inquiry, thereby transforming what we know about the world"[20]. Using DIY science as a method in participatory action research science can create an extremely effective research method that will promote global awareness, causing a collective effort to make a change to environmental policy.

## PARTICIPATORY ARTS BASED RESEARCH

Participatory artistic based research (PABR) is a research method that establishes a relationship between participants, art and science. In Klein's words, PABR is "any creative systematic activity undertaken in order to increase the stock of knowledge, including the knowledge of man, culture, and society" (Klein Julian). The researcher can portray their work to the public through their art, and record people's reactions to improve on their art as well as learn about their art from the people: "Artistic research is characteristically not research about or of, but a participatory act and reflection with a strong performative element" (Hannula, Suoranta, Vaden). One example of this research is artist Kat Austen's work on paleoplasticenes, which was developed to show the longevity of microplastics as well as how plastics affect the environment and how the environment adapted to the plastics. In this study, the artist created various plastic structures and placed them outside in nature, as shown below:

Figure 6: Studio Austen's Paleoplasticene

This public display of art allowed the community to see the research being done on a firsthand basis, instead of just being told the outcomes of the experiments. In this study, it was found that the ecosystems these plastics are placed in rapidly began to adapt. This included microorganisms that evolved to feed off plastics and plants evolved to take microplastics into their own tissue (Kat Austen). The paleoplasticene research is still active and is updated periodically by Kat Austen and her studio. The participants are able to see the timelapse of the art since it was planted to show how the plastic and the environment surrounding it has changed over time. PABR provides a different perspective to research, as its expressed through artwork unlike other traditional research that is expressed through collecting data through various protocols.

# METHODS

Our overall mission for this project was to research the best display methods and formats for each intended workshop audience and to create a set of templates that could house our sponsor's DIY workshop protocols. We used our own evaluation skills to refine prior protocols by addressing their flaws in our new sets of protocols. We also created surveys that will act as a feedback system for our sponsor's participants when they host workshops using our new protocols or for when participants decide to do these workshops by themselves. Our objectives were designed to attract a larger audience to the use of a more inclusive approach to scientific research, and more specifically, Studio Austen's environmentally sound DIY Workshops. Therefore, the various improvements to these workshops will be done through action research. Our primary objectives were to:

- Refine existing workshop protocols
- Optimize Workshop Display Methods
- Improve accessibility of workshop materials
- Create a feedback system and implement protocols

Studio Austen, a research enterprise at the intersection of art and science, has the mission of promoting a future that is more environmentally and socially just. The studio was founded and is currently run by Kat Austen, who received a PhD in chemistry at the University College London. She used this background to follow her true motivation, environmental awareness. She uses both her studio as well as a collective she co-founded, DIY Hack the Panke Collective, to continue research and promote environmental awareness. She is also a senior teaching fellow in Arts and Sciences at University College London. She has exhibited in many cities as well as performed her music around the world. Studio Austen incorporates artistic and scientific practices within the many DIY science workshops that the studio has designed to spread environmental awareness. These workshops helped educate the community surrounding Studio Austen about the environmental problems that are happening right in their own backyard. Now, Studio Austen plans to increase the accessibility and visibility of its workshops by publishing the protocols of each of its workshops in a clear and comprehensible fashion.

To read more about Studio Austen's workshops and projects, please refer to the sponsor description in Appendix A.

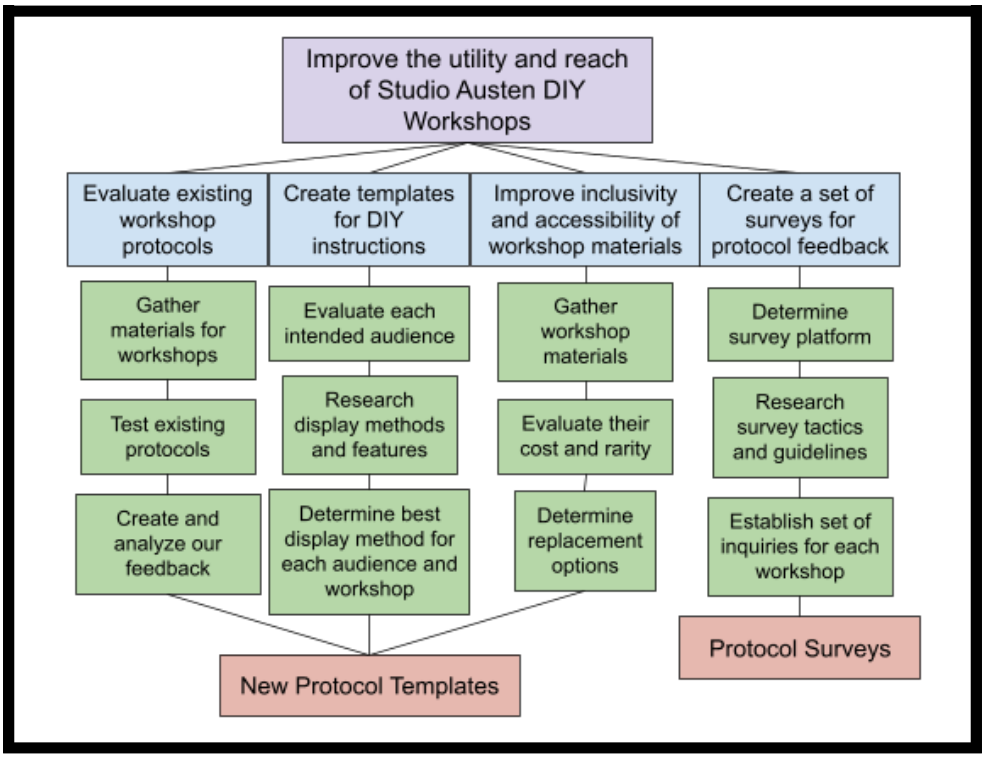



Figure 7: Methods Graphic

# OBJECTIVES

## OBJECTIVE #1: REFINE EXISTING WORKSHOP PROTOCOLS

The first objective is to refine the existing Studio Austen DIY Workshop protocols. Before our project, the materials and protocols were scattered on different sites and provided little information on how to complete the workshop. Instead of the participants being able to conduct the workshops themselves, the studio would present how to perform the protocols as a group. To refine the workshop protocols, we conducted and evaluated the workshops as participants. Secondly, our team performed and also presented some of the workshops that required engineering skills like soldering and mechanical assemblies to Studio Austen's intern. We reviewed the protocols before we presented them to the intern, in order to ensure we knew how and why every step of the protocols was necessary. Our team then performed the DIY experiments with the intern and collected their personal feedback. This process ensured that we gathered feedback from someone outside of our group so that the protocols would be intelligible for someone who might not have experience with common engineering practices. With the feedback we drew conclusions as to what specific features of the existing protocols must be changed or improved, and after this we established a set of changes that were implemented when creating the new Studio Austen protocols. This process should ensure that the new protocols are understandable for people with different perspectives and experiences, in order for them to be as inclusive and intelligible as possible.

## OBJECTIVE #2: OPTIMIZE DISPLAY METHODS FOR EACH DIY WORKSHOP

The second objective is to optimize the display methods for each workshop. For this objective, the intended audience was evaluated for each workshop to determine the best display methods and features. This objective consisted of building a clean, repeatable template for document-style workshop protocols. Our protocol design and wording had to be simplified to ensure that an average person with no prior knowledge on our protocol topics could successfully perform the experiments, understand them, and be able to analyze the purpose and impact that it was meant to invoke. Next, we needed to research some of the best display methods for each different intended audience to ensure that the protocols would be presented in the best way for each workshop's audience. The research process involved searching for multiple platforms where we could write protocols that were appealing and informative. This then led us to searching for multiple examples of workshop protocols that we found within Zotero, and then evaluating what features were used successfully so that we could gather a set of display methods to implement within our protocols. Then, we determined what features and format to implement for each workshop, and finally, we optimized our display styles for all of the workshops. This included taking pictures of workshop assembly progress, as well as organizing and evaluating the order and flow of workshop steps, which resulted in an efficient template that any set of workshop protocols could fit within.

## OBJECTIVE #3: IMPROVE ACCESSIBILITY OF DIY WORKSHOP MATERIALS

The third objective was to improve the utility and accessibility of the materials used for each workshop and once again reiterate protocols. First, we completed an inventory assessment and compiled all workshop materials. This included taking pictures of all items and creating a detailed list of the items' cost and purpose. The accessibility of each item was evaluated to determine if a replacement material would be more effective. If an item that Studio Austen currently uses can be found for a cheaper price while maintaining a similar range of places where it can be found, it is considered a candidate for replacement in the future. Naturally, when participants are doing these workshops from their homes, their materials will not all be the exact same, but price ranges for these items should be similar for most of the regions in which people perform the workshops. Replacement materials were written into the reiterated protocols for future testing and a table was made to show the recommended average cost for each material and for the overall workshop costs as well; the feedback from our surveys should ensure that the specific item we implemented is actually serving its purpose better than the last.

Despite attempting to reduce the cost of materials, our team could not find anything to cut or replace that would decrease the price. This was because Studio Austen had already implemented low cost materials for each workshop. Below is the estimated cost of each protocol based off of amazon prices:

**DIY Hydrophone Materials Cost**

| Material | Cost |
|---|---|
| piezos (10 pack) | $ 6.99 |
| Microphone cable | $ 2.56 |
| Electric jack plug | $ 5.99 |
| Hot glue gun | $ 14.00 |
| Wire stripper | $ 2.99 |
| Silicone seal dip | $ 7.97 |
| Total | $ 40.50 |

**Spectrometer Analysis Materials Cost**

| Material | Cost |
|---|---|
| Spectrometer (provided) | $ - |
| cuvette (4 pack) | $ 39.99 |
| CFL Lamp | $ 4.95 |
| Halogen Lamp | $ 1.98 |
| Filtrate sample | $ - |
| Solvent Sample | $ - |
| Total | $ 46.92 |

NOTE: Filtrate and solvent are from Extraction

**Microplastic Extraction Materials Cost**

| Material | Cost |
|---|---|
| Microplastics | $ - |
| Distilled Water (1 Gal) | $ 0.99 |
| Magnets | $ 7.99 |
| Plastic Bag | $ - |
| Testing Tube (Kits) | $ 15.00 |
| Magnetite (100g) | $ 8.62 |
| Oil (100 mL) | $ 5.49 |
| Electronic Microscope | $ 24.99 |
| Total | $ 63.08 |

**Chlorophyl Extraction Materials Cost**

| Material | Cost |
|---|---|
| Leaves/Parsley | $ - |
| Acetone | $ 4.03 |
| Measuring Cylinder | $ 3.99 |
| Filter Paper (100 pack) | $ 7.99 |
| Funnel | $ 5.61 |
| Pipette | $ 1.99 |
| Glass container/Bowl | $ - |
| Total | $ 23.61 |

**Density Column Materials Cost**

| Material | Cost |
|---|---|
| Honey | $ 2.99 |
| Agave Syrup | $ 1.79 |
| Dish Soap | $ 1.33 |
| Distilled Water (1 Gal) | $ 0.99 |
| Vegtable Oil (100mL) | $ 5.49 |
| 50 mL Graduated Cylinder | $ 3.99 |
| Plastics | $ - |
| Total | $ 16.58 |

NOTE: Anything without a price is a common household item
These are estimates. Prices may vary.

Figure 8: Cost Analysis Table

## OBJECTIVE #4: IMPLEMENT ONLINE FEEDBACK SYSTEM

The fourth objective was to create a set of surveys that will ensure that the protocols implemented are user-friendly. The surveys will also provide Studio Austen qualitative data about the protocols, allowing the studio to reiterate protocols in the future. For this objective, the protocols were equipped with a QR code on each workshop template which will directly link to the list of workshop protocols, and from this page participants will be able to select the survey or surveys for each of the workshops they participated in. We conducted research on some survey platforms such as Typeform, SurveyMonkey, as well as the studio's recommendation, Epicollect5. Research on survey guidelines and examples that would help us establish a helpful set of inquiries that could help Studio Austen collect feedback after our project is finished was also conducted.

Today, Studio Austen is able to utilize these surveys by using participatory action research. The studio would test the protocols. They would observe the participants and record their findings as well as collecting feedback from the surveys. They would then reflect on the feedback and use the PAR reiterative process shown in the figure below to improve their protocols further.

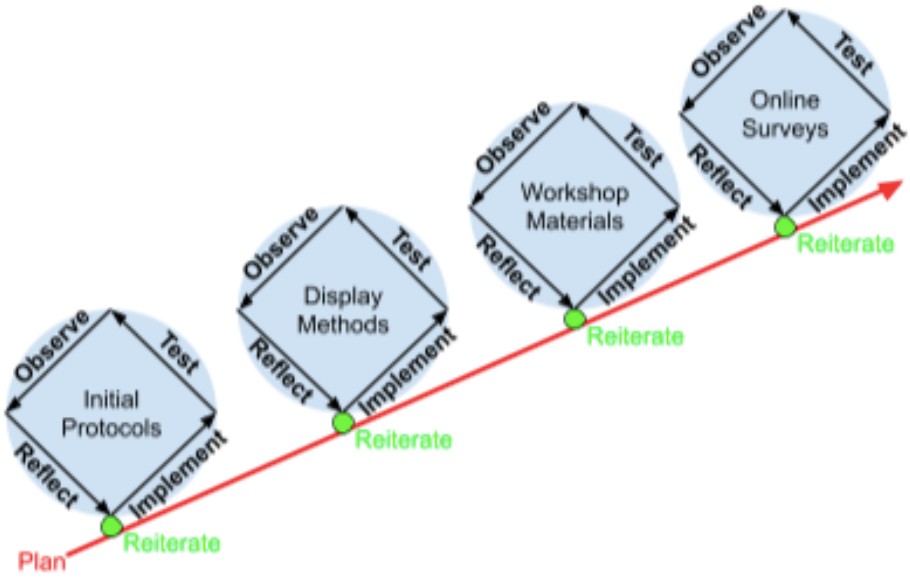



Figure 9: Objective Focused PAR Cycles

## OPTIMIZING THE INCLUSIVITY OF WORKSHOPS THROUGH TECHNICAL WRITING

To be able to complete our first two objectives, refining the existing protocols and optimizing the display methods, our team researched technical writing. Part of this research included interviewing a professor at WPI who specializes in technical writing, Kevin Lewis. In his own words, he described technical writing as "taking information that audiences don't understand and putting it in a way that they can understand it"[24]. Some of the aspects of the writing that we had to focus on were the clarity, brevity, simplicity and word choice[25]. In order to address these points, we had to recognize what audience we were writing for. After discussions between our group and our sponsor, we understood that we wanted our audience to be as broad as possible. We wanted an audience of most ages and all levels of education to be able to comprehend and perform our protocols. Our goal was to write these protocols to a point where almost any audience can understand them. However, due to the complexity of some of the protocols, our target audience would be high-school age and above. To accomplish our goal, we incorporated step by step instructions with very simple word choice. As an additional step, we also addressed the magical number 7, plus minus 2 rule, a widely used rule in technical writing[24]. It stipulates that an average person can store only 7 simple pieces of information, plus or minus 2 pieces[24]. Finally, we presented these protocols to Studio Austen's intern to ensure that the protocols that required engineering skills were intelligible for someone who might lack experience in this field.

After a discussion with our sponsor, it was decided that three templates would be created in order to enable us to explore different platforms, so that we could select the best display methods. The three templates made were the presentation style template, a laboratory protocol format template, and a Canva template. The presentation style was made more for the studio to present during the workshop with visual appeals that focus on the presenter to help the participants perform the workshop. The laboratory protocol format template was designed to represent what engineers or scientists would see when performing or writing their own protocols. The Canva template was created to have all the information that the conventional template would have, while being more visually appealing and simplified into smaller chunks to help the participants perform the protocols without being overwhelmed. After the creation of templates, another discussion between us and our sponsor took place in order to select the best template. The first template was created on Prezi, a video style presentation platform that utilizes visual effects to create a map layout:


Figure 10: Prezi Template

# RESULTS

This template was well organized and visually appealing. However, this template was designed for an audience that would be present at a workshop. It was meant to be presented by the studio to the audience. The template was also not PDF compatible, which is needed so the protocols can be printed out for those without mobile or internet access. After the discussion with our sponsor, we determined that the template is not ideal for at-home use, it lacks space for step-by-step instruction, and lacks PDF compatibility. For these reasons, we sought a different template.

The second template we created followed the basic format of technical writing that would be used by a STEM student/worker. This included single spacing, left justification, 12 point font, and 1 inch margins[26]. It included step-by-step instructions in an organized manner as well as followed a number of important aspects of technical writing such as simplicity, clarity and brevity[25]. This template also included images for each of the steps. The images in the steps are "an integral part of the technical communication process"[27], helping participants to get through each step with ease.

**DIY Hydrophones**

Created by: Kat Austen
Written by: Vasil Bozdo, Jose Rivera, and Ryan Trongone

**What are hydrophones and why do we use them?**

This will be the introduction of the lab describing what hydrophones are and what they are used for. This will also describe what a piezo is and how it works.(all in the notes from the experiment)

**Materials:**

- 2 piezos
- Microphone cable (between 1.5 and 2 meters)
- Electric jack plug
- Hot glue gun
- Hot glue
- Soldering iron
- Solder
- Wire stripper
- Silicone
- Audio recorder
- Headphones (with male audio jack)

**Protocols:**

1. Plug in and heat up the soldering iron
2. Cut a length of microphone wire between 1.5 and 2.5 meters.
3. Strip the wire approximately 3 cm on each end. Refer to image 1 in appendix B.
4. Cut the cotton down to the wire base. Then twist the ground wire (without plastic) to create a solid ground on both sides of the microphone wire. Refer to image 2 in appendix B.
5. Using the electric jack plug, unscrew the back of the jack. There are 3 sections of the jack, the ground, and two signals. Refer to image 3 in appendix B. place the back of the jack that was unscrewed on the microphone wire. Solder the ground of the microphone

Figure 11: Laboratory Style Template

However, there were still some problems that were raised by our sponsor. The images provided to help guide the reader were referenced in an appendix at the end of the template. This would cause the user to have to find the image after each step, as they were not on the same page. This was extremely important to our sponsor. Because the template was also almost all text with few to no images, it could be intimidating to a younger, less educated audience. Due to these issues, we sought a different template.

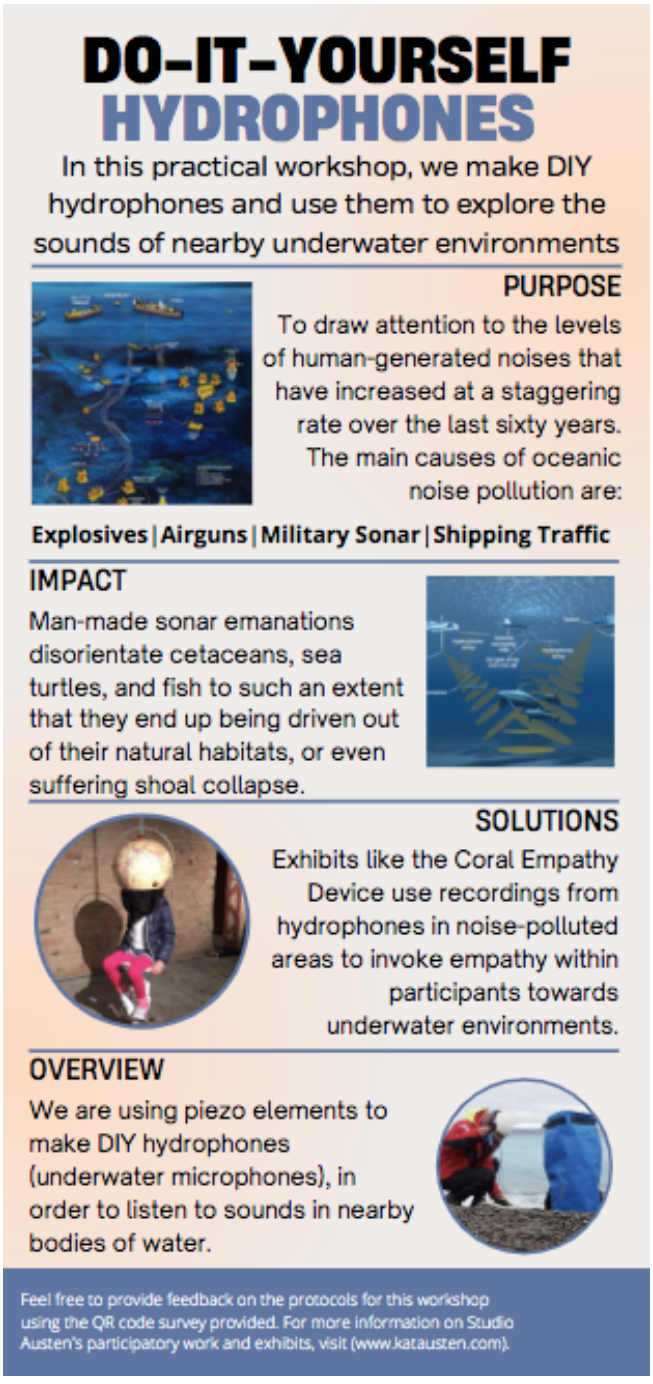
The third and final template was edited from an infographic template on Canva, a collaborative graphic design website that allowed all our team members to work on the protocols at the same time. The original infographic template provided by Canva is shown in Figure 12.


Figure 12: Canva Template

# RESULTS

This template was used for our cover page. It was selected because it had a pleasant graphic design, and it provided an adequate organization for us to introduce a workshop. Then the following pages were designed by our team. The template used after our edits relied not only on the aspects of technical writing mentioned in the last template, but also it incorporated visually appealing features for workshop participants.

It had a pleasant display of colors, which were all color blind friendly, with a variety of elements that are easy to manage within the site for if future changes needed to be made by our sponsor. It had clear instructions that were separated into small, manageable chunks including images directly adjacent to the step. Since we divide the chunks into no more than 5 steps, our protocols on this template also follow the 7 plus minus 2 rule. The template is shown in Figure 13.



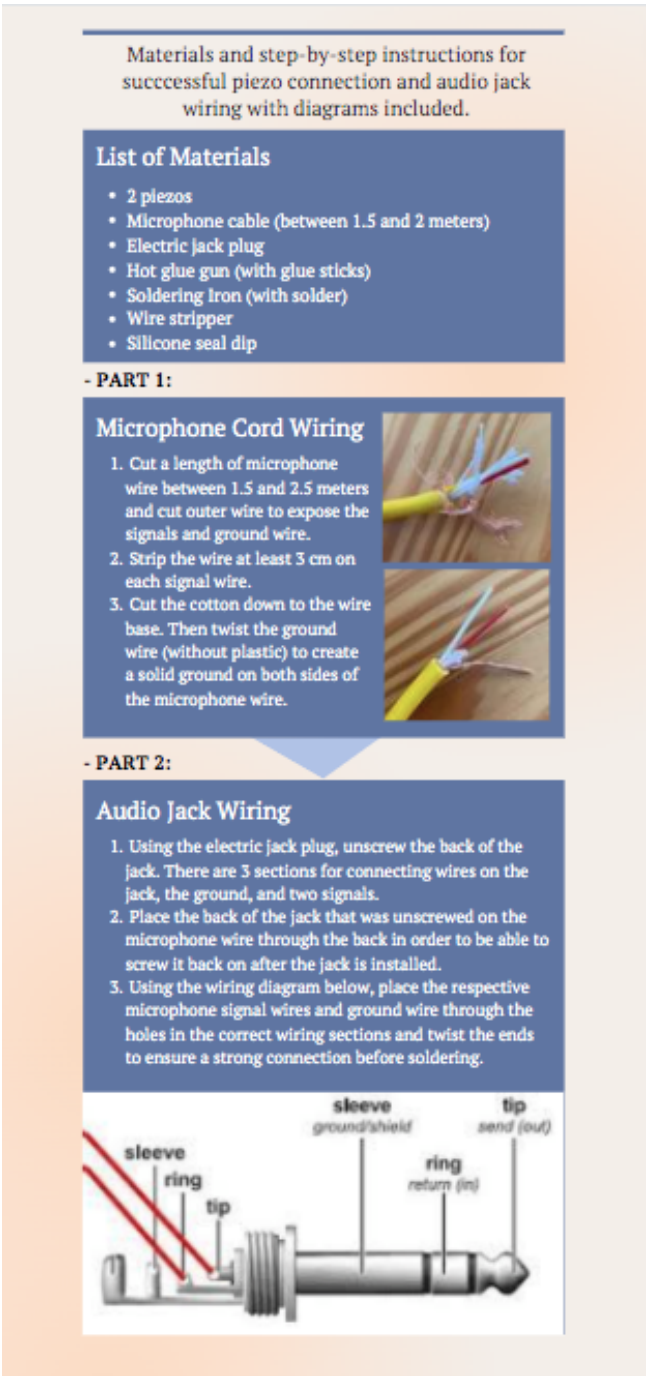




Figure 13: DIY Hydrophone Protocols within Canva

However, when we went to test print the templates in the later stages of the project, we realized that we could not fit the templates on a full page. Because of this, our team used a bifold template in Canva and redesigned it to look exactly like our previous design. The only difference is the width of the margins. The final template is shown in Figures 14 & 15.

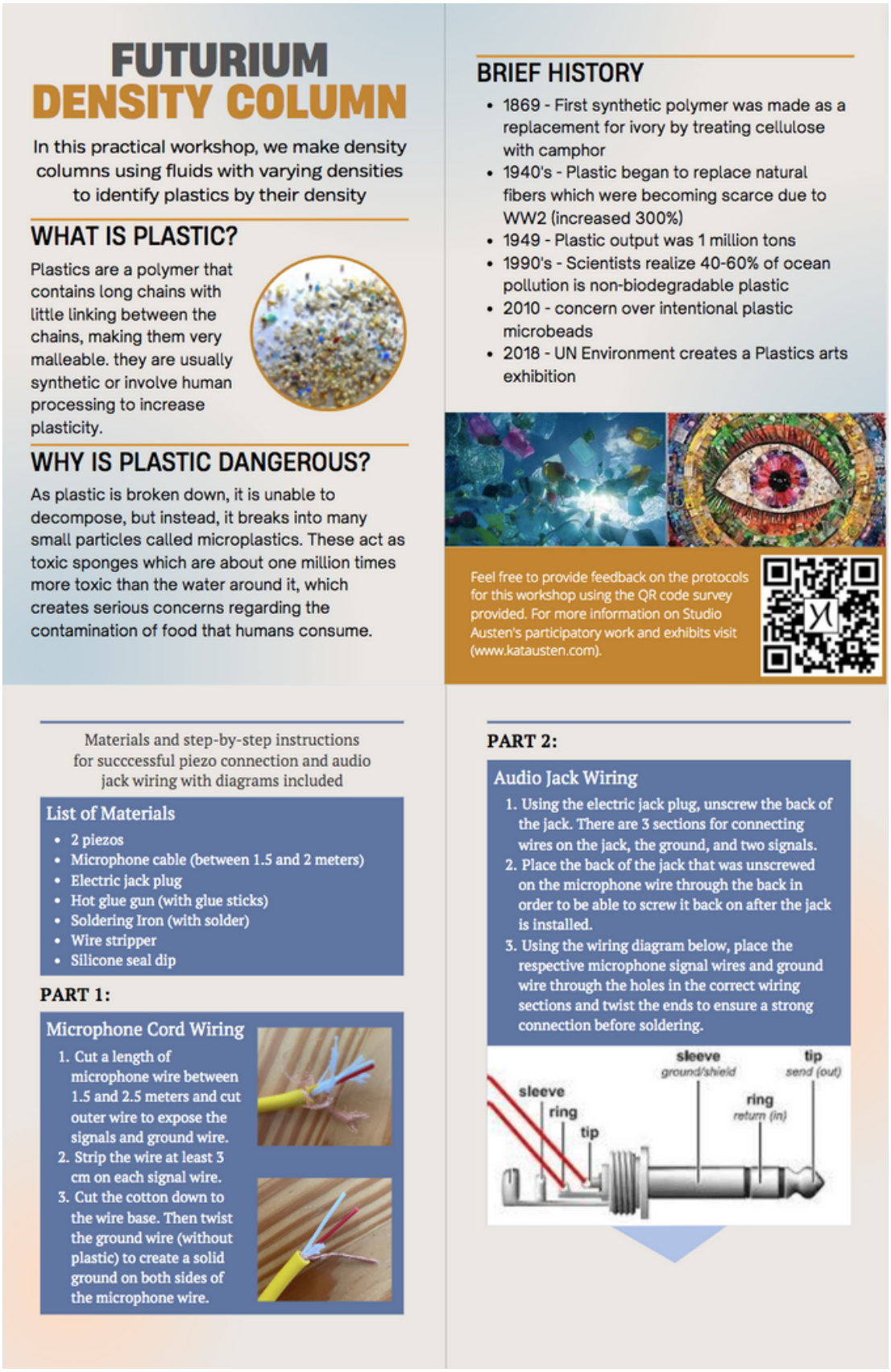



Figure 14 & 15: Bifold Template Introduction and Protocol Pages

## CONVEYING THE PURPOSE OF STUDIO AUSTEN'S WORKSHOPS

In order for participants to understand the philosophy and purpose of our protocols when they perform Studio Austen workshops, our team evaluated and performed the workshops along with the help of our sponsor. We likewise discussed with our sponsor the reasons for her interest in DIY science and how she conceives of its social significance. Many of the original workshops designed by Studio Austen were made to raise awareness of environmental issues that face the world. These workshops aim to inspire people to adapt positive practices during their everyday lives that will help mitigate the ramifications of environmental issues that the public faces. In order to convey the message that Studio Austen intends with each workshop, we decided to include sections that explained some of the difficult concepts, materials, and products that are important for the participants to fully grasp to understand the full scope of the workshops. Laying these concepts out in a simple manner helps non-specialists feel like they can participate in the fact-finding process during a time in which the gap between the public and scientific expertise causes so much skepticism within society. For example, there are many people in the world who challenge the legitimacy of things like climate change or even the effectiveness of vaccines. DIY workshops like Studio Austen's can help bridge the gap between scientific experts and the average citizen. This is because the research that participants perform helps form a relationship between them and the topic, but if some of the concepts are not understood, it can lead to a weak connection and the chances are that the participants will not adapt positive practices in their lives to combat environmental issues. Many of these concepts were addressed in the introduction sections of our protocols, before any steps were presented.

Studio Austen features workshops concerning the extraction of chemicals using different filtrates in order to extract specific chemicals from organic compounds. Some examples are lycopene extractions from tomatoes and chlorophyll extractions from leaves and vegetables like parsley. Chemicals like these are extracted in the Studio Austen workshops to view their light spectrums using DIY spectroscopy. These spectrums are then compared to reference spectrums in order to verify if the extraction was successful. However, these extracts can serve a multitude of purposes including being used as replacements for artificial coloring in food. "Bakery products are widely consumed by people all over the world. By providing natural alternatives to food's formulation and make them as a functional or healthier foods, we can try to increase the health parameters of life"[28]. These purposes align with the overall goal of environmental sustainability as a whole, which is to extend the life of the Earth's resources and wildlife so that there can be more generations that get to live healthy lives in the future, without worrying about the pressing environmental consequences that the generations from before have brought forward. Workshops like these can help people participate in research without the use of a laboratory, which changes their relationship to acquiring factual scientific knowledge since it is now viewed as something more accessible and inclusive. This is because it confirms that one does not need to be a scientist in order to care or do something about the problems that face the world.

Studio Austen's microplastic extraction and density column workshops focus on raising awareness of the dangers that microplastics pose to the wildlife and plants of affected environments. The density column workshop shows how plastics of different densities interact with fluids of varying densities; on the other hand, the microplastic extraction

workshop shows how it is possible to extract high percentages of the microplastics in a water and oil slurry known as ferrofluid, by using magnetite and magnets to attract the magnetite-infused slurry. These workshops serve to show that microplastics can't be fully extracted even with an extraction method created by Fionn Ferreira, which involved creating the ferrofluid to remove microplastics at a large scale. When Ferreira's ferrofluid attached itself to the microplastics, a magnet was used to separate the ferrofluid from the water, and after 5,000 tries he was 87% effective using his microplastic removal invention[29]. This method aims to provide a new, easy way to extract microplastics from bodies of water. It is incredibly important to convey this within our workshops because microplastics are a topic that has recently been brought into the spotlight. A method like this, which anyone can easily use to contribute to mitigating the issue of microplastics in bodies of water, can be a very inclusive tool for raising awareness to such a pressing issue. If our protocols address this properly, participants should feel motivated to contribute to this cause because it has the potential to seriously affect society on a daily basis.

After performing each workshop, we only implemented one change into our workshops' lists of materials due to higher functionality, while maintaining a similar level of accessibility. This was the piezo in the DIY Hydrophone protocol. Initially the Studio Austen protocols included one-signal piezos in its list of materials. However, we put both parts to the test by creating two DIY hydrophones. One was made with one-signal piezos, and the other was made with two-signal piezos in order to evaluate their similarities, differences and functionality. We discovered that two signal piezos work much better for building the hydrophones. This was because the microphone cable contains three wires, one ground and two signal wires. Since both the piezo and microphone have the same number of wires, each signal can be matched. With the piezo with just a ground and one signal, it can cause confusion on what the participant is supposed to be connecting to. The sound quality of the recordings was also better with the two-signal piezos. The cost of the two-signal piezos was not too far apart from the cost of the one-signal piezos, therefore the list of materials was updated.

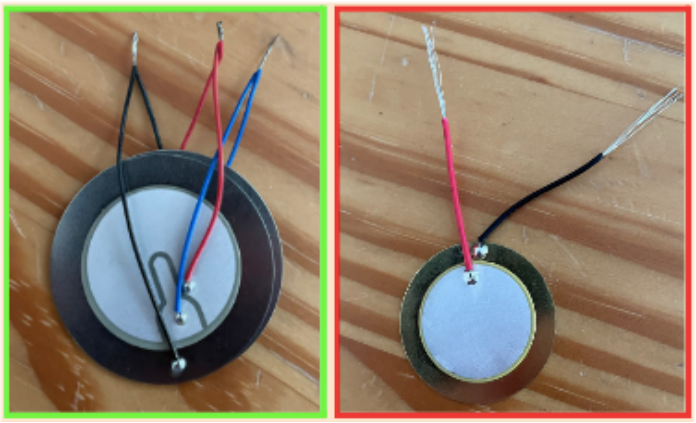


Figure 16: Piezo Replacement

Using their DIY Hydrophones, participants would then be able to participate in the Studio Austen listening practice workshop. These protocols aim to establish a relationship between humans and the environment around them whether it be inside or outside of a body of water. This is important because it was found that digital life, comfort, and increased protection from the earth's natural elements have combined to weaken human connection to what is considered the "natural" world [30]. This is especially present in underwater environments, since our oceans are so largely unexplored, people nowadays tend to fear what they don't know, which can tarnish the sense of empathy towards oceanic life for many people around the world. From Studio Austen's improved workshop protocols, participants should be able to create a bond with the wildlife and environment they observe and listen to closely. This should have an effect on participants much like the Studio Austen exhibit called "The Coral Empathy Device", which uses hydrophone recordings in order to provide an immersive experience for participants to communicate with coral. These conversations

were driven by embodied cognition and coral biology, to foster interactions with users that will create a relationship between people and such an important marine element like coral [31].

The philosophy that these workshops aim to communicate aligns with the overall mission of Studio Austen to promote a more socially and environmentally just future. The impact of these workshops becomes more efficient, which our new protocols aim to help promote. Our survey system is what will allow Studio Austen to gauge how effective our improvements have been, and if they need to perform any changes or improvements in the future.

## CREATING AN EFFECTIVE SURVEY FEEDBACK SYSTEM

Our team had to create a survey that would provide Studio Austen with improvements that are needed in the DIY Protocols, as well as gauging the impact the workshop had on the participant. In our surveys, we wanted to learn if and where the participants struggled while performing the protocols to improve them in the future, as well as what the participants have learned by performing the workshop. The first step in creating the surveys was how we were going to present the surveys. We had two possible options, paper surveys that were to be given out after the workshop was completed, or online surveys. We decided that online surveys are a superior option to paper surveys. This is because the studio will "Receive survey responses more quickly, lower copying and postage costs, and lower the amount of time for data entry", as well as eliminating errors that could be caused by data entry[32]. Instead, the surveys will be cost free, and will cut down the time to organize the data. The information given will also be easier to read since the information will be in text format instead of handwritten.

After deciding to use an online survey, our team had to choose a survey platform. Originally, our team was going to use Google Forms, a commonly used data-gathering platform used in the United States. However, after a discussion with our sponsor, we realized that this was not a viable option. This was because the data had to be stored only in European servers. Since Google has servers located outside of Europe, we needed to use a different platform. During this conversation, our sponsor recommended Epicollect5. Our team investigated her recommendation as well as other survey platforms, such as Survey Monkey and Typeform. We came to the conclusion that Epicollect5 was the best platform. This was because all of its servers were located in Europe and had many features other platforms did not. One of the most important features was the jump tool. This allowed us to create one survey that contained each individual protocol. After the participant chose the protocol they were providing feedback for, the survey would jump to that group of specific questions. It also provided an audio input. This allows the studio to collect audio from the DIY Hydrophone workshop (if the participants agree to a CC license).

When creating survey questions, each question had to be worded carefully. If worded incorrectly, we could create cognitive biases in the answers, making it an unethical survey [33]. For example, we couldn't ask the participants "has this protocol affected your view of the environment?". This is because the participants' instinct would be to say yes to conform with the social norms. This could skew the results of the survey, since they would most likely all be yes, even if the participant wasn't affected. Instead, we would ask very specific questions about the participants' knowledge after performing the protocol. For example, in the Microplastic Extraction survey, we ask "Was all the microplastic removed from the water? And what were you able to conclude from this when the microplastic removal is done on a larger scale?" This allows the studio to know whether or not

the participants were able to understand the learning outcomes of the workshop. When designing the survey, we also wanted the participants to be fully anonymous. With the participants identity protected, it has a greater chance to result in “more valid responses to the surveys”[34]. However, we had to make one exception in the Hydrophone survey to get a CC license for the studio to use the audio given by the participants. This section is completely optional and the participant does not need to state their name if they want to remain anonymous.

Organizing our questions was another step in the creation of the surveys. We started the survey with introduction questions. These included their age, level of education, and their primary language. These were put at the beginning because participants are used to seeing these types of questions, and have to put little to no thought into the answers. The survey then moved into basic questions to help improve the protocols. Then the surveys ended with more complex questions asking about the environmental aspects of the workshop and how it affected them. The surveys were organized in this way because the best way to sort the questions is to start with objective items to allow the participants to get used to the survey and become comfortable with answering questions. Then going into more complex questions as the survey goes on, ordering the survey “from most familiar to least familiar”[34].

Our team also had to find out the best possible way for the participants to access the surveys. We came to the conclusion that the best way to get access to the surveys is through QR codes. This will prevent the participant from having to type a long URL. Instead, they will only have to use their smartphone to scan the QR code on their camera, which will bring them directly to the survey link. Since a vast majority of the German population uses a smartphone[35], the surveys will be widely accessible when converted to a QR code. Our team also noticed that many Germans access online forms via QR codes. For example, all forms for information about registering for Covid-19 testing are accessed through QR codes in Germany. With the wide use of QR codes already used in Germany and the easy accessibility, our team agreed that utilizing them in our surveys would be extremely effective.

Figure 17: Studio Austen QR code

## BUILDING TOWARDS OPTIMIZED INCLUSIVITY AT STUDIO AUSTEN

Our mission was to assist Studio Austen in promoting a future that is more environmentally and socially just. To meet our goal, we researched aspects of technical writing and ways to optimize the display methods in order to deliver a new and improved set of protocols. We focused on writing with simplicity and clarity. We communicated the philosophy of each workshop in our protocols. Finally, we implemented a feedback system by utilizing Epicollect5, an European platform used to create surveys. The link to these surveys was implemented in our protocols through a QR code for easy access. The feedback collected by these surveys will be used by Studio Austen in order to further improve the protocols in the future.

Studio Austen utilizes its DIY workshops to perform environmental research. By assisting Studio Austen in creating a new set of protocols, we have tried to improve the accessibility and inclusivity of its workshops. By providing step by step instructions as well as a way to access these workshops without the necessary use of the internet, these workshops can now be performed from home in nearly any part of the world. This inclusive approach will make it possible for the average individual to participate more in environmental research and reconsive their relationship to facts and to knowledge production.

Unfortunately, during our time at Studio Austen there were no in-person workshops being held. In spring 2022, Kat Austen was preparing an art installation and COVID-19 restrictions made workshops an organizational challenge. For these reasons, we did not obtain in-person feedback directly from Studio Austen's intended audiences. In-person workshops would have enabled interviews with some of the main stakeholders of our project. Feedback from more perspectives, especially from people who are interested in Studio Austen projects, would allow a more inclusive result in our protocols that covered the needs of more people in general.

Before Studio Austen publishes the new protocols that we designed, we recommend that they hold trial workshops in order to evaluate how the new format, instructions, and impact for each workshop are received by their intended audiences. Trial workshops will allow for Studio Austen to make revisions to the protocols and format before they fully publish the new workshops. We also recommend that Studio Austen holds trials for people doing the workshops at home without guidance from the studio to ensure that our protocol improvements have made it easier for people to perform these workshops from home. Feedback from these trials could differ from the in-person trials, for which reason it could make sense for Studio Austen to create a separate set of protocols intended for usage at home.

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## APPENDIX A: SPONSOR DESCRIPTION

Studio Austen, a research enterprise at the intersection of art and science, has the mission of promoting a future that is more environmentally and socially just. The studio was founded and is currently run by Kat Austen, who received a PhD in chemistry at the University College London. She used this background to follow her true motivation, environmental awareness. She uses both her studio as well as a collective she co-founded, DIY Hack the Panke Collective, to continue research and promote environmental awareness. She is also a senior teaching fellow in Arts and Sciences at University College London. She has exhibited in many cities as well as performed her music around the world. Studio Austen incorporates Artistic and Scientific practices within the many DIY science workshops that the studio has designed to spread environmental awareness. These workshops include building DIY hydrophones from household items, using DIY chemistry to search for micronutrients in fruit, and even investigating store bought fish guts for microplastics. These workshops helped educate the community surrounding Studio Austen about the environmental problems that are happening right in their own backyard. Now, Studio Austen plans to increase the accessibility and visibility of their workshops by publishing the protocols of each of its workshops in a clear and comprehensible fashion. The studio also has a large variety of public exhibits that raise awareness to the ramifications of environmental issues, such as the Coral Empathy Device which uses recordings from hydrophones in noise-polluted areas to invoke empathy within participants towards underwater environments; This Land is not Mine, which is focused on the region of Lusatia, where Germany, Poland and the Czech Republic meet, the home of the Sorbian minority group. This new media project explores identity in a region of co-existing cultures that is undergoing fundamental socio-economic changes as brown coal mining in the region is phased out; finally, Stranger to the Trees is based on extensive interdisciplinary research that examines the incorporation and rejection between plastics and trees with the constant consideration of the possibility for complementarity and coexistence. While these exhibits can raise awareness to many of the ramifications of environmental problems that humanity faces today, we are focusing on revitalizing Studio Austen's workshops and making their protocols and materials more inclusive and understandable for as many audiences as possible.

## APPENDIX B: SPONSOR INTERVIEW MINUTES

Conclusions:

1. She is moving to Seoul for a fellowship to create bioplastic long playing records (similar to vinyl records)
    a. These will be the first in the world
    b. Will reduce our carbon footprint
2. Will have Studio Austen continue in berlin as well as attempting to open a new Studio in Seoul
3. Hopes to see her Studio become a solid enterprise with worldwide recognition
    a. Hopes to be in public records to amplify her message

## APPENDIX B: SPONSOR INTERVIEW MINUTES

**Introduction:**

1. Can you tell us about you? What is your practice and how did you get to where you are today?
    a. Her practice is Participatory Artistic Research focused in music and artistic/environmental displays.
    b. Has a background in Sciences with a doctorate in chemistry.
    c. She left her background in chemistry to become an artist informed by her chemistry background.
    d. She used to perform in a band before splitting off to create her studio.
    e. All of her projects are created by our relationship to the environment.
    f. Forum theater
        i. Gives a voice to non-human entities while accepting them as legitimate entities
    g. Art is not her first motivation, even though most of her work is art
        i. Its mainly the environment that drives her passion
    h. We are at a critical point in history where her work can help change the policies in the environment by spreading her knowledge.
2. How do you incorporate Participatory Artistic Research in your work?
    a. Does an undergrad program program at University of London
        i. Explores food
        ii. Undergrads work with younger students (usually highschool) for their participatory research
    b. Public Workshops
        i. Uses groups of 20 people
            1. Any more will make the process too chaotic
        ii. Personally doesn't do any advertising
            1. Organizations giving her projects do some advertising
            2. People just seem interested and come without any persuasion through advertising
        iii. Also uses various online platforms to share her methods
            1. Both with people interesting in doing them as well as creators sharing with Kat
        iv. Had some trouble during covid due to the tight restrictions in Berlin
        v. Just received funds for her next research project, Stranger to the trees
            1. We will be there when she starts this project
        vi. Some workshops, people pay by workshop, others are payed by the organizations creating them.
        vii. New album released on spotify
            1. Giving us 3 redeem codes to listen to her album
3. We saw you are also a co-founder of the DIY Hack the Planke Collective. Can you tell us about it?
    a. Was set up 4 years ago
    b. Planke River runs through Berlin
    c. This collective investigates our relationship to the Planke River through participatory action and artistic research
    d. Developed series of workshops on Planke River
        i. Microplastics
        ii. Sounds of the river
    e. There will be a Hack the Planke exhibition that we will be attending while in Berlin

## APPENDIX B: SPONSOR INTERVIEW MINUTES

**Our Project:**

1. What do you see us doing in our project for studio austen
    a. Her methods with a sense of agency needs to be shared with the world
    b. She herself is so stretched out, she needs help organizing all of her materials and methods and to make them easily accessible to the public
        i. Currently, her materials are spread out everywhere
        ii. She will share a list after this meeting
    c. Create PDFs or Videos?
        i. We do not need web design background
    d. Wants to incorporate FAIR Research
        i. Findability
        ii. Accessibility
        iii. Interoperability
        iv. Reusability
    e. Wants to be able to affect the change in policy of knowledge
    f. Wants to present diversity in a nice manner while allowing us to show why she is doing her workshops
    g. The projects given to her by organizations are not easy to understand
        i. We need to reword these projects to make it more understandable to those without the proper knowledge
    h. Research the best way on how to bring all her projects together
        i. Universal framework or project specific
    i. We will be 3D printing a microscope based off the IBM Microscope
2. How is DIY incorporated into your research?
    a. DIY has been adapted to be more inclusive to the average person with limited to no barriers
    b. Share methods and learn from her participatory research
        i. Wants our feedback after doing her workshops
            1. Make sure they are understandable and easy to do (with instruction)

## APPENDIX C: JUSTIN POLCARI INTERVIEW

Introduction:

1. Can you tell us a little about who you are and what you do?
    a. I'm a research coordinator at a neuroscience lab at WPI as well as a research associate at a gene therapy lab at UMass medical school.
2. Would you say your current occupation is within the fields of conventional science and which one?
    a. Currently I'm in two labs that are considered academia labs where we pursue clinical research opportunities in the field of neurology.
    b. In the neuroscience lab at WPI, we are researching biomarkers of chronic pain using different modalities in neuroscience including ephnears and tracking. For the gene therapy lab we are researching different neurological disorders including neurofibromas, which involves tumors specific to the central nervous system.

How is conventional sciences specialized:

1. How specialized is this work? What have you done to get to your current position?
    a. I was a biotechnology and biology major as well as professional writing major with a minor in chemistry and the filament of the pre-medicine track.
    b. I am currently in the gene therapy lab which is super site-specific, we work with small molecular biochemistry.
    c. We also use CRISPR and cast 9 2 sequence DNA and potentially curate using gene therapy vectors and bacteria
    d. We use bigger machines such as MRI
2. How hard would it be for you to receive an opportunity like this without access to a professional education?
    a. Extremely Challenging
    b. You need more experience and hands-on experience specifically not necessarily the backgrounds of it but hands-on research is very necessary.
3. Do you know what these types of approaches are and what Citizen science and DIY science could bring to the table?
    a. Never done that research specifically
    b. This type of research can be beneficial to complementary techniques, stemming from academic work or clinical research.
    c. A community outreach can be a huge part of where you start locally, and can get preliminary data and expand to a larger cohort that will give you a better scope of the population that could only be informed from the participants.
4. How would you present your data? Is there multiple ways to portray the data based on the audiences you want to connect with?
    a. Hard copies and paper copies are great for the older generation who aren't as tech savy.
    b. Can also utilize social media such as instagram and facebook for the younger generations
5. Could your research in conventional science help adopt citizen science or could DIY science be utilized in your research?
    a. So I'll speak to the neuroscience Lab that I work in. Because it doesn't pertain to the true therapy. If we ran a preliminary trial of a peon grant looking at biomarkers of propane and of course when you look and conduct a study like this you need to recruit two cohorts one with pain and one without.

## APPENDIX C: JUSTIN POLCARI INTERVIEW

6. To recruiters or individuals we have to utilize a DIY kind of method. This research is outside the box so since people with chronic pain are usually older, we had to use flyers and pretty much spread them across bunch of buildings in hopes to recruit individuals but we also had to utilize online teleprompters around campus to attract younger audiences. Different places were utilized to try to get the numbers that we were looking for as well as the diversity of test subjects.

## APPENDIX D: KEVIN LEWIS INTERVIEW

**Introduction:**

1. Can you tell us what your definition of technical writing is?
    a. Taking information that audiences don't understand and put it in a way that is understandable
    b. More about taking any information that the audience understands. Everyone understands different things based on their background
    c. Take that information and make it accessible and understandable
    d. Deliverable can be a speech, not only writing
2. What is technical writing involved in?
    a. Survey question are a mean to get information
    b. Know the experience of the users
    c. Write and design the material better
3. Survey questions meant to give feedback. Is there an aspect on making these questions more efficient?
    a. Anything other than getting information is unethical in a survey
    b. Do not "lead the audience"
        i. Keep neutral questions
        ii. If not passionate, use that in your research
4. What languages can create empathy to the audience?
    a. Use the three rhetorical writing strategies
        i. Ethos
            1. Use content so they can understand/perform. Need to have that feeling that if they do not follow the steps, there will be consequences
            2. Be authoritative
        ii. Logos
            1. Use Data to show the people the problem
        iii. Pathos
            1. Appeal to the readers emotion to show what could happen in the future
            2. Be careful to not lead with the audience again.
5. We showed you our drafts of our protocols. We know you had some comments. We would appreciate it if you could tell us your thoughts.
    a. The reader needs motivation to follow the steps
    b. You need to understand the audience. You need to make sure they know what they are doing.
        i. Make sure that all materials are described if they understand
        ii. Define things at the beginning
        iii. Could change language so you arent using technical terms
    c. All starts at the beginning
        i. Has to look approachable
        ii. Needs the audience to know that they can do it at home
    d. The reader needs to understand both the purpose of the document and the protocol
    e. Make sure everything is separated into clear sections
    f. Create a road map for the reader
        i. Create almost a table of contents saying all the tasks that will be at hand
        ii. To build your hydrophones, you will need to do the following tasks.

## APPENDIX D: KEVIN LEWIS INTERVIEW

g. Images are crucial in technical writing
    i. Helps the reader understand what they need to do
h. You have utilized a crucial rule in technical writing called the 7 plus minus 2 rule
    i. The reader can remember 5 complex instructions and up to seven simple instructions.

## APPENDIX E: LISTENING PRACTICES

# LISTENING PRACTICES

In this practical workshop, we will use recording devices to explore the sounds of environment

### OVERVIEW

Hearing is one of our senses, however, listening is something we don't practice enough. We often disregard a number of sounds as "background noise". These sounds range from the loudest to the faintest. Being able to identify a single sound is just as important as recognizing that it's there. All these sounds together identify an environment.

### PURPOSE

The combination of the background sounds plays an important role in the identity of a region. Some sounds tell a story and will have an obvious start and finish. These stories identify a certain region and make us more aware of our surroundings. Listening to these sounds as recordings in different locations will help individuals from different corners of the world to identify a place they have never been to.

Feel free to provide feedback on the protocols for this workshop using the QR code survey provided or click here. For more information on Studio Austen's participatory work and exhibits visit (www.katausten.com).

Materials and step-by-step instructions for successful recordings with pictures included

### List of Materials

- A recording device
- Optional: external microphone
- (Bethel) or scarf
- Smartphone

### Privacy Policy

1. When you upload a file, the location of your recording and your name will be collected.
2. Your name will be used so that you will be credited on the project
3. For your privacy, your name will not be linked to your recording or it's location.

**- PART 1:**

### Preparing the Recording Device

1. Make sure you have enough battery in your recording device
2. If you have a choice, record into a wide format for the best possible sound.
3. Get your recording device as close to the source of the sound as you can.
4. Point your microphone towards the sound you want to record.

Notes and Reflections:

## APPENDIX E: LISTENING PRACTICES

- PART 2:

### Performing a Successful Recording

1. If you are recording in a windy environment, place a wind muff on top of your recording device.
2. If you can't get a hold of a wind muff, loosely wrap a scarf around your microphone.
3. Once the recording is in progress, do not move. Any movement will get picked up by the microphone.
4. Do not record people speaking.
5. Some sounds will have an obvious start and finish. If not, then record for roughly one minute.


- PART 3:

### Uploading a Recording

1. Only upload recordings shorter than five minutes. If your recording is longer, please cut it down to your favorite part.
2. Do not upload recordings of people speaking.
3. Using your smartphone, note down the coordinates of the location where the recording was performed.
4. Visit https://lausitzklang.katausten.com/ website, click "Sounds of Lusatia Upload Form" and upload your recording.


Notes and Reflections:

## APPENDIX F: HYDROPHONE PROTOCOLS

# DO-IT-YOURSELF HYDROPHONES

In this practical workshop, we use piezo elements to make underwater microphones, also known as **DIY hydrophones**

### OVERVIEW

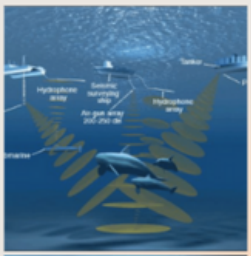
We are using piezo elements, which can convert sound that is traveling through water into electrical signals, to make underwater microphones (hydrophones). In order to listen to sounds in any nearby body of water

### PURPOSE

To draw attention to the levels of human-generated noises that have increased at a staggering rate over the last sixty years.

### IMPACT

Man-made sonar emanations disorientate cetaceans, sea turtles, and fish to such an extent that they end up being driven out of their natural habitats, or even suffering shoal collapse. The main causes of oceanic noise pollution are:



**Explosives, Airguns, Military Sonar, Shipping Traffic**

Feel free to provide feedback on the protocols for this workshop using the QR code survey provided. For more information on Studio Austen's participatory work and exhibits visit (www.katausten.com).

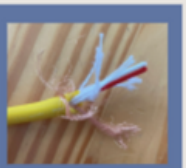
Materials and step-by-step instructions for succcessful piezo connection and audio jack wiring with diagrams included

### List of Materials

- 2 piezos
- Microphone cable (between 1.5 and 2 meters)
- Electric jack plug
- Hot glue gun (with glue sticks)
- Soldering Iron (with solder)
- Wire stripper
- Silicone seal dip

**PART 1:**

### Microphone Cord Wiring

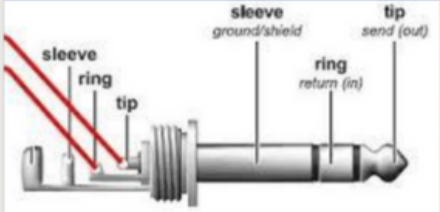


1. Cut a length of microphone wire between 1.5 and 2.5 meters and cut outer wire to expose the signals and ground wire.
2. Strip the wire at least 3 cm on each signal wire.
3. Cut the cotton down to the wire base. Then twist the ground wire (without plastic) to create a solid ground on both sides of the microphone wire.

**PART 2:**

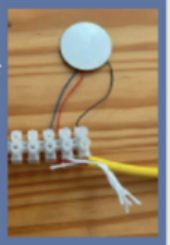
### Audio Jack Wiring

1. Using the electric jack plug, unscrew the back of the jack. There are 3 sections for connecting wires on the jack, the ground, and two signals.
2. Place the back of the jack that was unscrewed on the microphone wire through the back in order to be able to screw it back on after the jack is installed.
3. Using the wiring diagram below, place the respective microphone signal wires and ground wire through the holes in the correct wiring sections and twist the ends to ensure a strong connection before soldering.



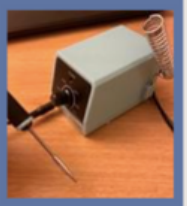
# APPENDIX F: HYDROPHONE PROTOCOLS

## Audio Jack Wiring Test



1. Place a piezo in the testing grid with each wire in a different section. On the other side of the testing device, match the ground and the signal wires together.
2. Screw the top of the testing sites in to make sure the wires do not move.
3. Turn on the recording device and plug in headphones to the recorder's output.
4. Plug the jack into the input of the recording device. Then, turn the recorder on and press record. Gently tap on the piezo. If a noise is broadcasted through the recorder, the wiring of the jack was successful.
5. If there is no noise, the audio jack wiring is either incorrect, or there is contact between the signal and/or ground wires, which can be fixed by carefully using hot glue to keep the wires apart within the jack and retest.

## Soldering Overview and Safety Guidelines



1. In order to create a good connection between wires with solder, wire contact in the right position is necessary.
2. When the soldering iron is on, ***be aware that the tip will need to be very hot*** in order to melt the solder.
3. When the wires are in the correct orientation, use the hot iron to melt solder onto the tip and then use the drop of solder on the tip of the iron to connect the wires.
4. Solder the wires together from multiple angles to improve connection and ***wait for the metal to cool down*** before touching it or sealing the solder with electrical tape or silicone seal dip.

**PART 3:**

## Piezo Connection

1. Place the two Piezos back to back, so the wires are on the outside and hot glue the sides of the piezos to hold the two together with a watertight seal in between.
2. On the piezo, there are three wires. The red and blue are signal wires and the black is the ground wire. Cut the wires to at least 3 cm to make an easier seal in a later step.
3. Connect the wires from each piezo together by color in order to make a solid set of signal and ground connections to attach onto the microphone wires.
4. Match the microphone and piezo wires together accordingly. In this case, it was red-to-red, blue-to-white, and the black wire to ground.
5. Since a successful connection has been established, go ahead and solder these wires and the audio jack wiring together as well.

**Notes and Reflections:**

**PART 4:**

## Hydrophone Sealing


1. Hot glue the sides of the piezos to hold the two together with a watertight seal in between.
2. Hot glue the wires away from each other to make sure there are no short circuits.
3. Dip the piezo into liquid silicone down to the microphone wire to create a watertight seal. This may have to be done more than once.

**Image Citation**

https://www.onegreenplanet.org/news/new-silent-oceans-campaign-raises-awareness-about-oceanic-noise-pollution/

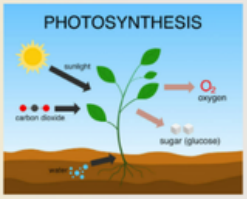
## APPENDIX G: CHOROPHYLL EXTRACTION

# CHLOROPHYLL EXTRACTION

In this practical workshop, we will extract chlorophyll from leaves using acetone

### OVERVIEW

Plants are organisms that differently from animals, produce their own food. This is possible due to a certain chemical that is inside of them, named chlorophyll. This chemical is responsible for absorbing the sunlight, and along with carbon dioxide and water, plants are able to go through a process called "photosynthesis", in which plants produce oxygen as well as glucose, their source of energy.




### PURPOSE

Parsley is a great source of chlorophyll, which can be extracted from its leaves. Chlorophyll can be beneficial to our health. Chlorophyll is an antioxidant which can reduce cell damage in our bodies, detoxify our blood, boost immune system and it is believed to even be able to prevent certain cancers.

Feel free to provide feedback on the protocols for this workshop using the QR code survey provided or click here. For more information on Studio Austen's participatory work and exhibits visit (www.katausten.com).

Materials and step-by-step instructions for successful chlorophyll extraction with pictures and included

### List of Materials

- 2 grams of parsley
- Acetone
- Spectrometer
- Measuring cylinder
- Filter paper
- Funnel
- Pipette
- 2 Glass Containers

### Safety Guidelines

1. Caution: Acetone is a highly flammable substance.
2. Acetone is a toxic substance, therefore do not consume it.
3. Wear gloves, goggles and lab coats at all times.
4. Conduct the experiment in a well ventilated room to avoid breathing high amounts of acetone.

### - PART 1:

### Preparing the solution

1. Measure 2 grams of parsley.
2. Grind the parsley leaves using either a knife or your hands.
3. Fill a glass container with 50 ml of acetone.
4. Mix the parsley into this container to initiate chlorophyll extraction.

Notes and Reflections:

## APPENDIX G: CHOROPHYLL EXTRACTION

- PART 2:

### Retaining the filtrate

1. Swirl the solution for the next 5 minutes until the once clear liquid inside the glass container turns green.
2. Place the filter paper on top of a funnel, and drop the solution through the filter, into another glass container.
3. Using a pipette retain the filtrate (the green liquid) by placing it into a glass cuvette.
4. With this solution, you will be able to perform a spectral analysis on the extracted chemicals from this workshop.

Notes and Reflections:

### CITATIONS

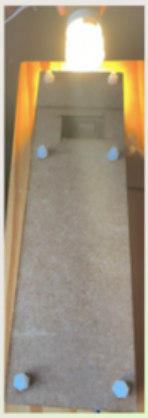

- "Download Parsley Leaf PNG Images Background PNG - Free PNG Images." TopPNG, https://toppng.com/parsley-leaf-PNG-free-PNG-Images_12079.
- ai_yoshi. "Vektorillustration Des Photosyntheseprozesses." IStock, https://www.istockphoto.com/de/vektor/photosynthese-gm1292516712-387291153.

## APPENDIX H: SPECTROSCOPY DOCUMENTATION PROTOCOLS

# SPECTROSCOPY DOCUMENTATION

In this practical workshop, we use DIY spectrometers to capture, measure, and analyze different light spectra to find specific molecules

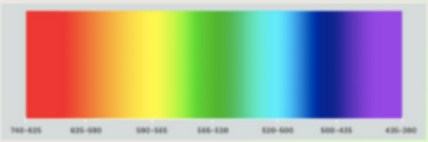
### HOW DOES A SPECTROMETER WORK?



The design of a modern spectrometer is an assembly of a slitted screen, a diffraction grating and a photodetector. The screen allows a beam of light into the interior of the spectrometer, where the light passes through the diffraction grating. The grating splits the light into a beam of its component colors, similar to a prism. The light then reflects onto a detector that picks up individual wavelengths.

### PURPOSE

Light is made up of a spectrum of colors. We see this in rainbows. Light is changed when it passes through liquids or solids, and by measuring this change we can work out what molecules the liquid or solid contains. This is called spectral analysis.



**Notes and Reflections:**

Feel free to provide feedback on the protocols for this workshop using the QR code survey provided. For more information on Studio Austen's participatory work and exhibits visit (www.katausten.com).

Materials and step-by-step instructions for successful spectrometer calibration and spectrum collection in spectralworkbench.org

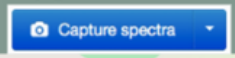
### List of Materials

- Spectrometer
- Computer or Laptop
- Cuvettes
- CFL Lamp
- Halogen Light Source
- Filtrate sample
- Solvent sample

**PART 1:**

### Spectrometer and spectralworkbench.org

1. Set up spectrometer by connecting it using a USB-port to a laptop or computer.
2. Open spectralworkbench.org and create a free account in order to begin calibration.
3. Open the "Capture Spectra" page in the top right of the home page.




### Tips for Successful Calibration

- In order to verify that the spectrometer is working and being used, ensure a black screen is visible on the top left. A spectrum should be visible there if a light is pointed towards the spectrometer lens.
- If your spectrometer is not sealed well, light may enter the imaging chamber and mess up your readings. Make sure the top of the spectrometer where the sample is inserted has been closed before capturing a spectrum. This can also cause overexposure that creates flattened peaks which are detrimental for good results.


- Sometimes, when using the "waterfall" interface in live capture, you don't quite catch that moment when a flare of light is just perfect. You can use Set cross section under "Tools" on the spectrum page to choose the best cross-section of the image.
- When performing the calibration, ensure that the spectrum is in the right orientation. Like the image above, the blue should be on the left, and the red on the right. If you see it come up the opposite way, simply press the "Flip Image" option to reorientate.

## APPENDIX H: SPECTROSCOPY DOCUMENTATION PROTOCOLS

**PART 2:**

### Spectrometer Calibration

1. Using a CFL bulb, shine the light into the spectrometer without a sample and observe. Capture a spectrum similar to the one below for a successful calibration, the better the Fit # on the top right of the spectrum, the better the calibration. Follow the steps below from Public Lab to ensure a successful calibration.


**Notes and Reflections:**

### Sample Spectrum Collection

1. Switch the light source from the CFL Lamp used for calibration to a Halogen bulb, reference Halogen spectrum below.
2. Use calibration spectrum taken with the CFL to calibrate the next spectra.
3. Take spectrums of samples with filtrate and solute apart in order to establish the difference between the solutions being analyzed based on the peaks of their spectra.
4. Subtract solvent spectrum from filtrate spectrum in order to gain the spectrum of the extracted chemical.
5. Compare the remaining spectrum to published spectra in order to identify the extracted chemical

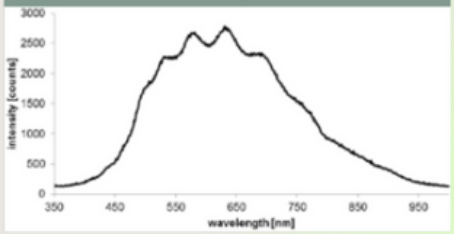



Image Citations

1. Halogen Light Spectrum:
Thoms, Lars-Jochen & Girwidz, Raimund. (2013). Experimenting from a Distance: Optical Spectrometry via the Internet.

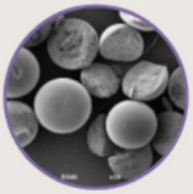
## APPENDIX I:MICROPLASTIC EXTRACTION PROTOCOLS

# MICROPLASTIC EXTRACTION

In this practical workshop, we use a method created by Fionn Ferreira to separate microplastics from water using magnetite

### WHAT ARE MICROPLASTICS?

Microplastics are plastics between 1 - 5000 µm (0.001 - 5mm) in size. This material has long carbon chains with little linking between chains, making them very malleable. These are the outcome of large plastics breaking down into multiple pieces, it was found that a single plastic bottle can turn into over 10,000 pieces of microplastics.



### IMPACT

"Polyethylene and polypropylene are the types of plastic that have the highest market share in Europe. Unsurprisingly, the majority of particles analyzed were also made of these types of plastics. The irregular, fragmentary appearance of most particles suggest that they are fragments of larger plastic objects. In addition, plastic fibers were discovered at many sampling sites."

- Mikroplastik in Binnengewässern Süd- und Westdeutschlands14Kat Austen, 2019Futurium, Berlin, Germany

Plastic microfiber samples, source: Patagonia

Feel free to provide feedback on the protocols for this workshop using the QR code survey provided. For more information on Studio Austen's participatory work and exhibits visit (www.katausten.com).

Materials and step-by-step instructions for successful microplastic removal with images included

### List of Materials

- Some form of microplastics
- Distilled water
- Magnets
- Plastic bag
- Testing tube
- Magnetite
- Oil
- Electronic microscope

**PART 1:**

### Setting up extraction

1. Insert a chunk of microplastics into a test tube
2. Add 15 mL of distilled water into the test tube
3. Add 5 mL of oil into the test tube
4. Add 1 tablespoon of magnetite into the test tube
5. Cover the top of the test tube and shake thoroughly.

**PART 2:**

### Microplastic extraction

1. Put your magnets in a smaller test tube or plastic bag to prevent difficultly in clean up after the extraction.
2. Dip the magnets in the large test tube. Since the magnetite is magnetic, it will adhere to the magnets with the microplastics mixed in.
3. Scrape the magnetite into a petri dish.
4. Repeat steps 2 and 3, two more times
5. Pour the remainder of the distilled water into a petri dish

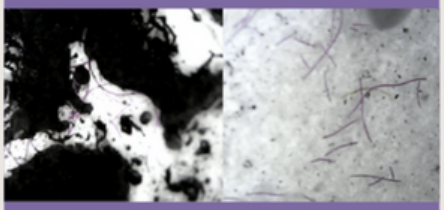
Magnetite | Water after extraction

## APPENDIX I:MICROPLASTIC EXTRACTION PROTOCOLS

**PART 3:**

Observation

1. Plug the electronic microscope into your computer.
2. Open your computer's camera app.
3. In the settings of the app, switch the camera to the microscope.
4. Set the microscope up looking into one of the petri dishes and focus as necessary.
5. Observe the microplastics in both dishes.



Magnetite | Water after extraction

NOTE: Notice how there are microplastics in both samples. What can you conclude after observing these images?

**Notes and Reflections:**

## APPENDIX J:FUTURIUM DENSITY COLUMN PROTOCOLS

# FUTURIUM DENSITY COLUMN

In this practical workshop, we make density columns using fluids with varying densities to identify plastics by their density

### WHAT IS PLASTIC?

Plastics are a polymer that contains long chains with little linking between the chains, making them very malleable. they are usually synthetic or involve human processing to increase plasticity.

### WHY IS PLASTIC DANGEROUS?

As plastic is broken down, it is unable to decompose, but instead, it breaks into many small particles called microplastics. These act as toxic sponges which are about one million times more toxic than the water around it, which creates serious concerns regarding the contamination of food that humans consume.

### BRIEF HISTORY

- 1869 - First synthetic polymer was made as a replacement for ivory by treating cellulose with camphor
- 1940's - Plastic began to replace natural fibers which were becoming scarce due to WW2 (increased 300%)
- 1949 - Plastic output was 1 million tons
- 1990's - Scientists realize 40-60% of ocean pollution is non-biodegradable plastic
- 2010 - concern over intentional plastic microbeads
- 2018 - UN Environment creates a Plastics arts exhibition

Feel free to provide feedback on the protocols for this workshop using the QR code survey provided. For more information on Studio Austen's participatory work and exhibits visit (www.katausten.com).

Materials and step-by-step instructions for creating a density column with pictures and identification diagram included

### List of Materials

- Honey
- Agave Syrup
- Dish Soap
- Water
- Vegetable oil
- 50 mL Graduated Cylinder
- Small pieces of plastic

**PART 1:**

### Setting up the Density Column

1. Set up a graduated cylinder on a level surface.
2. Begin adding 5 mL layers from most dense to least dense. Please read the note below before starting to pour the column layers.

- NOTE: When adding the honey and agave syrup, try your best not to get it on the sides of the graduated cylinder. instead pour directly in the center. When pouring the rest, use the side of the graduated cylinder to prevent them from mixing.

### Fluid Pouring Order

1. Honey (Density = 1.42 g/mL)
2. Agave Syrup (Density = 1.33 g/mL)
3. Dish Soap (Density = 1.04 g/mL)
4. Water (Density = 1 g/mL)
5. Vegetable Oil (Density = 0.92 g/mL)

**Notes and Reflections:**

## APPENDIX J:FUTURIUM DENSITY COLUMN PROTOCOLS

**PART 2:**

### Testing to Identify Plastics

1. Drop a small piece of plastic into the density column. The plastic should sink down, but stop just between the two layers that its density is between.
2. To make sure the plastic does not get stuck from surface tension, carefully tap the graduated cylinder against the table to break the surface tension.
3. It might take up to 30 mins for the microplastics to reach their actual density level due to it having to break the surface tension of the different fluids.
4. After they have settled, you will notice that some plastics will be at the top, bottom or hovering within their respective layer. This is due to the relative density of the plastics to the fluid layer that they are in.

**Notes and Reflections:**

### Testing to Identify Plastics

- Use the density table provided to estimate what type of plastic is being used when testing an unknown microplastic:
- Feel free to use unidentified microplastics, this can be a good way to identify and analyze random microplastics.

| Layer | Density | Plastic | Use | Recycling # |
|---|---|---|---|---|
| Vegetable oil | 0.92 | Low density polyethylene (LDPE) Polypropylene (PP) | squeezy bottles, plastic bags | 4 5 |
| Water | 1 | High density polyethylene (HDPE) | toiletry bottles etc. | 2 |
| Dish Soap | 1.04 | Polystyrene (PS) | packaging materials | 6 |
| Agave syrup (diluted) | 1.33 | Polyethylene Terephthalate (PETE) | drinks bottles | 1 |
| Honey | 1.42 | Polyvinyl chloride (PVC) | Cooking oil bottles, pipes | 3 |

## APPENDIX K:SURVEY QUESTIONS

Introduction questions:

- What is your age?
  - Text answer
- What is your highest level of education?
  - None
  - Highschool
  - Highschool Diploma
  - GED
  - College
  - Prefer not to answer
- What is your primary language?
  - Text answer

Protocol selection:

- What protocol are you providing feedback for?
  - DIY Hydrophones
  - Spectrometer Analysis
  - Futurium Density Column
  - Futurium Microplastic Extraction
  - Chlorophyll Extraction

DIY Hydrophone questions:

- Were there any sections of the protocols that you struggled to understand?
  - Yes
  - No
- If you answered yes to the previous question, please state what section(s) that you struggled with.
  - Text answer
- Were there any terms or language that you did not understand?
  - Yes
  - No
- If you answered yes to the previous section, please list the terms and language that you did not understand.
  - Text answer
- Were you able to obtain all the materials to perform the protocols?
  - Yes
  - No
- If you answered no to the previous question, please list the materials you were not able to obtain.
  - Text answer
- While using the hydrophones, what sounds were more distinct?
  - Natural sounds
  - Man made sounds
- If you would like to share a sound file with Studio Austen, please attach here
  - MP4 upload
- By checking the box below, you agree to a Creative Commons license with the files downloaded above, giving Studio Austen permission to use your audio.
  - I agree
  - No

## APPENDIX K:SURVEY QUESTIONS

- If you would like to be credited with the audio, please state your name.
  - Text answer
- Would you recommend this workshop to a friend?
  - Yes
  - No

Listening Practice:

- Were there any sections of the protocols that you struggled to understand?
  - Yes
  - No
- If you answered yes to the previous question, please state what section(s) that you struggled with.
  - Text answer
- Were there any terms or language that you did not understand?
  - Yes
  - No
- If you answered yes to the previous section, please list the terms and language that you did not understand.
  - Text answer
- What sounds were more distinct?
  - Man-made sounds
  - Natural sounds
- Were you able to hear sounds both near you and far from you?
  - Yes
  - No
- Can you list some of the sounds that you heard during your listening practice?
  - Text answer

Spectrometer Analysis:

- Were there any sections of the protocols that you struggled to understand?
  - Yes
  - No
- If you answered yes to the previous question, please state what section(s) that you struggled with.
  - Text answer
- Were there any terms or language that you did not understand?
  - Yes
  - No
- If you answered yes to the previous section, please list the terms and language that you did not understand.
  - Text answer
- Were you able to obtain all the materials to perform the protocols?
  - Yes
  - No
- If you answered no to the previous question, please list the materials you were not able to obtain.
  - Text answer

## APPENDIX K:SURVEY QUESTIONS

- Were you able to successfully identify the chlorophyll based on the peaks of the spectra?
  - Yes
  - No
- Would you recommend this workshop to a friend?
  - Yes
  - No

Futurium Density Column

- Were there any sections of the protocols that you struggled to understand?
  - Yes
  - No
- If you answered yes to the previous question, please state what section(s) that you struggled with.
  - Text answer
- Were there any terms or language that you did not understand?
  - Yes
  - No
- If you answered yes to the previous section, please list the terms and language that you did not understand.
  - Text answer
- Were you able to obtain all the materials to perform the protocols?
  - Yes
  - No
- If you answered no to the previous question, please list the materials you were not able to obtain.
  - Text answer
- Did you use plastics with known densities?
  - Yes
  - No
- If you answered yes to the previous question, did the densities of the plastics align with the results of the workshop?
  - Yes
  - No
- What conclusion can you draw from the density variety in different plastics?
  - Text Answer
- Would you recommend this workshop to a friend?

Futurium Microplastic Extraction:

- Were there any sections of the protocols that you struggled to understand?
  - Yes
  - No
- If you answered yes to the previous question, please state what section(s) that you struggled with.
  - Text answer
- Were there any terms or language that you did not understand?
  - Yes
  - No

## APPENDIX K:SURVEY QUESTIONS

- If you answered yes to the previous section, please list the terms and language that you did not understand.
  - Text answer

Chlorophyll Extraction:

- Were there any sections of the protocols that you struggled to understand?
  - Yes
  - No
- If you answered yes to the previous question, please state what section(s) that you struggled with.
  - Text answer
- Were there any terms or language that you did not understand?
  - Yes
  - No
- If you answered yes to the previous section, please list the terms and language that you did not understand.
  - Text answer
- Were you able to obtain all the materials to perform the protocols?
  - Yes
  - No
- If you answered no to the previous question, please list the materials you were not able to obtain.
  - Text answer
- What type of plant did you use to extract chlorophyll from?
  - Text Answer
- Were you able to successfully extract the chlorophyll?
  - Text answer
- Would you recommend this workshop to a friend?
  - Yes
  - No

Conclusion:

- Thank you for helping Studio Austen improve their workshops!