

Educating citizen scientists on their roles to prevent  
citizen science washing with the help of the  
*Reflecto-tool*

13.06.2023

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# Abstract

In 2022, a case study was conducted on the Incentive project, where a cluster of Horizon 2020 citizen science projects were analyzed based on several parameters such as funding and timeframe. The results showed that 68% of projects, were considered not related to citizen science. Citizen science is an emerging field where citizens contribute to a research project through different methods. Based on this, the concept of citizen science washing was founded. The goal of this paper is to find the best methods to help citizens reflect on their roles within citizens science projects. This should be helpful enough to increase the motivation of citizen scientists and stakeholders to reduce the occurrence of citizen science washing. By applying the principles from the creative technology design process, a web-based tool was built and tested which provides tailored educational advice to the participant with the intention of shaping their role in the citizen science project they are participating in. The results gathered from the evaluations sessions showed that the Refleco-tool had in fact a positive influence on the reflection level of the participants. Through focus groups, interviews and observations several good points were noted for future recommendations, such as designing different questions for citizens and researchers to increase the effectiveness of the tool.

# Acknowledgements

I would like to thank my supervisors Femke Nijboer and Champika Ranasinghe for their support and guidance during my graduation semester. Moreover, I would also like to thank all the participants who participated in the interviews and evaluation sessions. Lastly, I would like to thank Henrietta Lukacs, my partner, who was supporting me through this process all the way from the beginning to the end.

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# 1. Introduction

## 1.1 Introduction

Citizen science is an emerging discipline among citizens and the scientific community. The term “citizen science” firstly emerged in 1989 January in the MIT technology review, where it promoted three ongoing community driven environmental projects. Scientists recognized the opportunity for a large-scale community involvement to contribute to a shared database of data and information.

Citizen science can be defined in several different ways. Firstly, a discipline where people or regular citizens are involved in a data collection process, which contributes to information development, social action and justice. The involvement of the public in data collection processes needs to provide information to some aspect of scientific research in order to be considered ‘citizen science’ (Eitzel et al., 2017). Secondly, citizen science can also be defined as a field in which citizens act as volunteers who are not necessarily scientists, are not paid and who participate as aids in scientific studies. Citizen scientists help monitor air quality, wild animals, keep communities together by having a joint interest in environmental trends, ecological research or simply because of their love of nature (Cohn, 2008). In many cases only the passion for a certain topic can act as a primary motivator to join a citizen science project or to start a new one.

In order to create a solid foundation for all the research initiatives that could be considered Citizen Science, the European Association of Citizen Science published the Ten principles of citizen science as a guideline of what can be considered a citizen science project. The first principle states that:

*“Citizen science projects actively involve citizens in scientific endeavor that generates new knowledge or understanding. Citizens may act as contributors, collaborators, or as project leader and have a meaningful role in the project.” (ECSA, 2015)*

Further down the research question will be presented, but before that, the concept of citizen science washing should be formulated. *Citizen science washing* is a term derived from green

washing. In this context it can mean that funding from the European commission could have been forgetfully mis-distributed as well as unknowledgeable or inattentive workers could have taken advantage of the system by making projects seem connected to citizen science but in reality they hardly were.

In the case of my graduation project I am not interested in why citizen science washing is happening since that is out of the scope of my research and expertise, but I will be focusing on through what methods can this phenomenon be reduced or controlled. That is how I arrived to the following research question:

**“What are the most suitable methods to guide citizen scientists and researchers about their roles in citizen science projects in order to reduce the effects of *citizen science washing*?”**

I test this on data collected by the Incentive project. This leads to the following sub questions:

- 1) How can the findings of projects be summarized and used to tailor the given advice?
- 2) What are the roles of citizens and stakeholders?
- 3) What is the best method to help citizens and researchers reflect on their roles within citizen science projects?

The first sub question is answered with a case study. In this study we performed an analysis of 215 citizen science projects in Europe. This study was part of project Incentive. Incentive is a co-funded project with the European union within the Horizon 2020 program. The goal of the project is to build four citizen science hubs in the four participating countries and universities:

- University of Twente (the Netherlands)
- Autonomous University of Barcelona (Spain)
- Aristotle University of Thessaloniki (Greece)
- Vilnius Gediminas Technical University (Lithuania)

With this in mind Incentive aims to make universities more inclusive and open under the principles of Responsible Research and Innovation. (Incentive, 2019). We report this in section 2.1 in a traditional way.

The second and third sub questions, about the roles of stakeholders, citizens and project leaders, will be answered through interviews with 4 experts from different citizen science projects (section 2.2).

## 1.2 Project goal

The goal of this project is to find the best methods to convey information to participants of a citizen science project, both citizens and researchers. The method to convey information is what I am searching for. It should be educational and it should be provided in a positively framed setting. Furthermore, the chosen method should make the participants reflect on their roles, and help them be more conscious when exercising their citizen scientist role. This in fact could be a factor in the occurrence of citizen science washing.

It is important to mention, that optimally, the occurrence of citizen science washing should be measured before and after, in the long term where the selected method was deployed to be tested.



## 2. Background research

This chapter is dedicated to present the case study mentioned in the previous chapter, and to show the current methods for conveying information. These methods include data visualizations and survey type questionnaires as well. Moreover the results of the interviews with experts is also be presented where the roles of participants in citizen science projects is discussed.

### 2.1.1 A traditional report on case study on citizen science projects in Europe - Incentive

Incentive is a Horizon 2020 project with grant Agreement number 101005330 aiming to establish four Citizen Science Hubs in Europe including the Netherlands. We want to establish a synergy with the citizen science Netherlands initiative by getting better insights into the landscape of citizen science in the Netherlands, Greece, Spain and Lithuania.

Through another branch of this project two researchers from the university of Twente and ECSA (ECSA, 2015) and I started mapping and out and analyzing citizen science projects from the countries mentioned above. The goal was to get insight on how current projects are funded, what domain do they focus on, what partners (especially: institutions) are participating and what the role of citizens is in the project.

To achieve this, the first step was to scrape online data bases (e.g., CS initiative), EU portals (Cordis) and web search (“citizen science”, “burgerwetenschap”) and bring the different projects to a spreadsheet into clusters based on the UN’s Sustainable Development Goals.

With this we explain the steps taken to collect and analyze the data as a means to map Citizen Science projects currently running in the four above mentioned countries.

### 2.1.2 EU projects: Data collection steps

All the projects we collected were selected from CORDIS with the following filters set up:

1. Keywords: ‘citizen’ AND ‘science’
2. Start date: 2020.01.01. and end date: 2022.08.31
3. Organization country: Netherlands/Spain/Greece/Lithuania

Since the projects all had the tag "Citizen science" it was important to first make a selection that split them into separate groups.

The excel sheet used for the analysis contained three distinct sheets labeled as "Citizen Science" projects, "NOT CS" projects, and "Unsure" projects. These labels were based on the first principle of Citizen Science, which involves the active involvement of the public in scientific research. (ECSA, 2015)

The overall selection was then based on this principle, as well as the other principles outlined in the document titled "The ten principles of citizen science" (ECSA, 2015). To make the selection process easier, the project description was generally checked for terms such as citizen, stakeholders, cooperation, and non-academic. While some were easy to distinguish, such as a non-citizen science project being a company that conducted research in a high medical field where non-expert input would not help the project, a citizen science project where groups came together to brainstorm and allow citizens' opinions to further the project. In some instances, it was not clearly explained how much the citizen contributed to the project. They were, for example, invited to conduct a survey and it was not clearly stated how much they were involved after this by ECSA (European Citizen Science Association) we decided in which sheet does the project we are looking at belongs to.

The CS projects sheet contains the following columns:

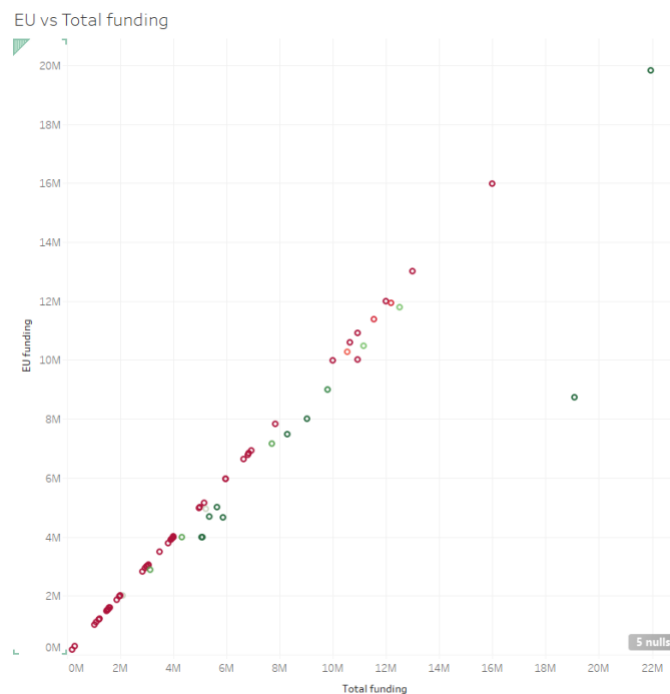
1. Name
2. Start date
3. End date
4. Total funding
5. EU funding
6. EU funding % of Total
7. Link – Grant ID
8. Research Area
9. Research Area score
10. SDG 1->17

### 2.1.3 Data analysis

After sorting, we started analyzing all the CS projects using the Analytics Workbench (*Analytics Workbench*, 2020). We decided to record the first five SDGs (Sustainable Development Goals) with their score and the first research area. The reason we chose to record the first five results instead of only the first one to have a reference point to the latter options and to be able to locate invalid scores. Invalid scores could occur because of the Analytics Workbench tool and its own internal algorithm.

After the analysis was done, we noticed that SDG 1, 9, 10, 11, 12 and 13 reappeared multiple times as clusters in many projects. This meant that similar projects had similar goals regarding the SDGs. Moreover, when looking at funding, it became clear that most of the projects are entirely funded by the EU.

I inserted the graph below to show the proportion of funding from the European Union versus external parties. I find this important from the perspective of “why?” is citizen science washing happening. I do not discuss this in this paper, but the topic could definitely be discussed and investigated further.

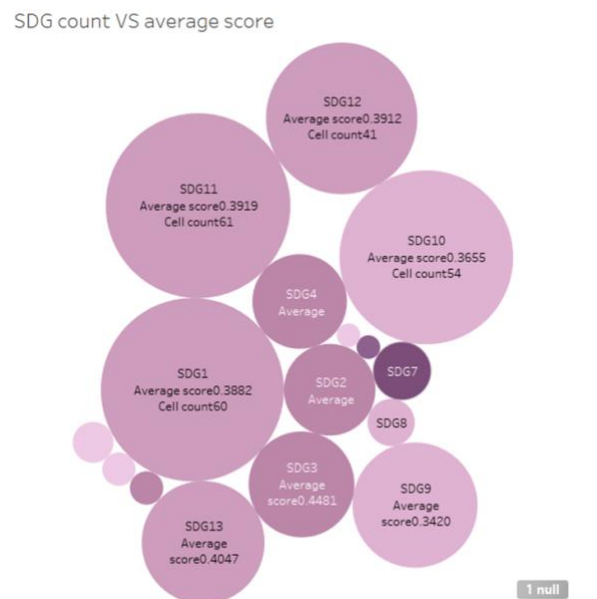


**Fig. 1** Funding from the European Union vs. Total funding of projects

The redder the dot the closer to 100% EU funding. The green dots represent a value between 85% and 98%.

Below we can see a graph where we compare how accurate the SDG scores really are. (Meaning: presence VS score) As you see SDG 11 appears in 61 projects, but its score is only 0.39. On the other hand, SDG 7 has the highest score with 0.61 but only within 6 projects. The algorithm from Analytics Workbench is providing these scores based on the description and objective of the projects. I do not have the exact knowledge on how does it calculate the scores. (*Analytics Workbench, 2020*)

The scores are given from 0 to 1. Zero meaning 0% correlation with the respective SDG or research area, and 1 meaning 100% correlation.



**Fig. 2** SDGs vs. SDG average scores

Moreover, we also wanted to know which research area is the most funded in the Netherlands. As you can see, it turns out that is **public administration** with a total of 56 million euros of investment. It was also interesting to see that despite the reputation of the Netherlands concerning **water management**, SDG 6 (Clean water and sanitation) came up only once out of 84 projects.

After classifying the data based on the 5 SDGs, we narrowed it down to only one SDG/project (the one which yielded the highest score).

After counting, we noticed that SDG 1, 3 and 11 were taking the lead in terms of popularity among all the SDGs. Earlier, when we used 5 SDGs to classify, we found that SDG 1, 9, 10, 11, 12 and 13 were consistently appearing in clusters but with lower scores. We can also see that by comparing the average SDG score of the data set with 5 SDGs and the one with only one SDG selected.

$$5 \text{ SDGs} - 0.3942 < 0.47498 - 1 \text{ SDG}$$

We could say that from the standpoint of accuracy using 1 SDG is more effective than 5 SDGs. In the future we could experiment with 2 or 3 SDGs and see what kind of results we can get from there.

### Citizen science in the Netherlands

	Total funding	EU funding	EU % of Total
CS	€ 436.688.966,47	€ 407.489.410,20	93%
Not CS	€ 736.302.531,88	€ 592.362.025,01	80%
Unsure	€ 89.303.620,91	€ 84.596.218,09	95 %
	€ 1.262.295.117	€ 1.084.447.653	85%

**Table 1.** Ratio of citizen science projects in the

The analysis reveals that 31% of the projects in the dataset are classified as citizen science. It was also observed that the majority of citizen science projects were fully funded by the EU. The table below presents only the data with both, total and EU funding information.

	Total funding	EU funding	EU % of Total
CS	€ 436.688.966,47	€ 407.489.410,20	93%

**Table 2.** Total funding vs. EU funding + proportion

## 2.1.4 Comparison between countries

	Total funding	EU funding	“real” CS funding	# CS projects	Euro/ project (AVG)
Netherlands	€ 1.538.737.885,38	€ 1.468.039.974,54	€ 436.688.966,47	83	€ 5.261.312
	<b>100%</b>		<b>32%</b>		
Greece	€ 298.282.649,14	€ 283.824.885,22	€ 122.139.588,64	19	€ 6.428.399
Lithuania	€ 260.765.704,4	€ 186.720.388,93	€ 96.742.071,00	27	€ 3.583.039
Spain	€ 1.178.662.263,87	€ 1.055.604.585,95	€ 353.056.111,08	87	€ 4.058.116

**Table 3.** Incentive countries funding

The table above represents the total amount of funding each country received for citizen science projects including a column where the proportion of the EU funding is displayed. Furthermore, it also represents the amount of the funding from the projects we decided upon to be “real citizen science”.

Based on this data it is inevitable to notice the low proportions of “real” citizen science projects compared to the total funding the specific country received from the EU. This is the reason why reducing citizen science washing is so important. There are many “real” citizen science projects that could have used the money but never got a spot at the table.

## 2.2 Interview results

As mentioned in the introduction, in this subchapter, sub-question 2 and 3 will be answered.

In the second part of my graduation thesis I participated at a citizen science conference at the University of Twente where several speakers presented their projects. These people were deeply acquainted with citizen science projects since all of them presented their own project at the event. After the conference, I asked four speakers if they would be willing to conduct a short interview with me. It turned out that they were all excited about it so I managed to gather some crucial information about citizen science and about the role of the people in the project.

This interviews were based on four short questions as listed below:

- Please define a citizen science project.
- How would you organize a citizen science project differently?
- What stake do you hold in the project? How do you exercise your role as a stakeholder?
- Where do you think the line is between science and citizen science?

Some of these questions were not asked at every participant since I wanted to leave this interview semi-structured. This way extra insights could be discovered. Down below are the most important conclusions from the four interviews.

1. CS projects involve members of society, citizens, in a role that goes beyond of being a study participant
2. Participants are object of study but active co-researchers or active data collectors
3. Citizens should know what is being studied and what is the research question behind
4. There is a difference in roles between researchers and citizens within a citizen science project, because of the professional position of the individual
5. "In their experience" the line between doing citizen science vs. science lies at the scale of the project, meaning that the bigger the project the more common to have "low-key" citizen contributions, as well as the amount of information the citizens have about the project.
6. "Level of engagement is not a problem."
7. Stakeholders have the role to define the research question of the project, because usually some of them are scientists or have a background in research.
8. Stakeholders should dress accordingly when working with regular citizens. They should not give the impression of being a "grown up researcher" but a partner instead. Being natural is important.
9. They are many "champions of citizen science".

## 2.3 State of the art

The aim of the project is to find a methodology with the help of technology that can help in shaping the roles of the citizen scientists involved in citizen science projects. By helping them better understand the responsibilities and the characters they can have within a Citizen Science project, I aim to decrease the amount of Citizen Science washing that is happening.

The upcoming section of the paper introduces the theoretical background on human perception and how the data physicalization can have a changing effect on it. The background of this research project involved the analysis of more than 500 Citizen Science projects which provided valuable insights into the importance of understanding the roles of the participant in these projects. Therefore, this chapter of the paper focuses on underlying theories that can have an influence on the roles that are taken up in Citizen Science projects.

## **The connection between Citizen Science washing and other types of “washing”**

In this section I will introduce the founding idea behind the Citizen Science washing, a phenomenon that I observed during the analysis of the projects. The aspects and the theoretical background of Citizen Science washing can be closely related to green washing. The term “green washing” is the combination of green and brainwashing, a term introduced already in the end of the 20th century, when firms started to look into ways of satisfying their environmentally conscious consumers by showcasing their work as sustainable, while in reality they were still using the same environmentally degrading practices (Majláth, 2016). Greenpeace defines greenwashing as “[...] a PR tactic used to make a company or product appear environmentally friendly, without meaningfully reducing its environmental impact” (What is greenwashing?, Greenpeace UK). This can be related to Citizen Science projects in a similar manner, referring to Citizen Science washing as the act when the project applications are submitted and granted funding for a Citizen Science activity, while they do not focus on Citizen Science.

### **Human perception**

Physical data visualizations have significant benefit on human perception. Since humans have an advanced sensory and motor system data physicalizations can affect their perception differently than visuals on a computer. Thus, more and different types of information can be extracted as well (Calvert, 2004; Jansen, Dragicevic, Isenberg, et al., 2015). This can be divided into four big categories:

#### *1. Active perception*

Data physicalization taps into infinite tangible possibilities where the person can interact physically with the object, Jansen gave a perfect example of this: “a physical object like a hand-sized physicalization can be visually inspected by turning it around, by moving it closer, or by taking it apart. A large-scale physicalization can be explored by walking around.” When compared to a digital visualization, only our eyes as sensors perceive information on a flat screen. That can also be a problem when the visualization consists of large digital spaces which usually are hard to navigate with a mouse and a keyboard. Intuitive methods were developed to counter this issue but none of them were as reliable as a physicalization (Jansen, Dragicevic, Isenberg, et al., 2015).



## *2. Depth perception*

Real-life physicalizations have a great advantage over their digital brother. They intensely utilize our special perception skills. Moreover, the presence of 3D space, shapes and volumes help to perceive the object or physicalization in a more accurate manner compared to a computer screen (Yvonne Jansen, 2013).

## *3. Non-visual senses*

Visual stimuli is only one of the many humans can use to perceive. By using touching, other properties can be revealed, such as texture, temperature or material. Moreover hearing, smell and taste can contribute in the same manner sight to diversify perception, all of them with a unique features (Hornecker, 2011). This is how physicalizations can transfer different types of knowledge which digitally would be impossible (Jansen, Dragicevic, Isenberg, et al., 2015).

## *4. Intermodal perception*

Intermodal perception refers to a mix of multiple types of perception which lead to realistic multisensory experiences. In other words, different senses work together in order to give an accurate representation of an object, as the author states: “, stroking a surface produces sounds that nuance tactile information on texture” (Jansen, Dragicevic, Isenberg, et al., 2015).

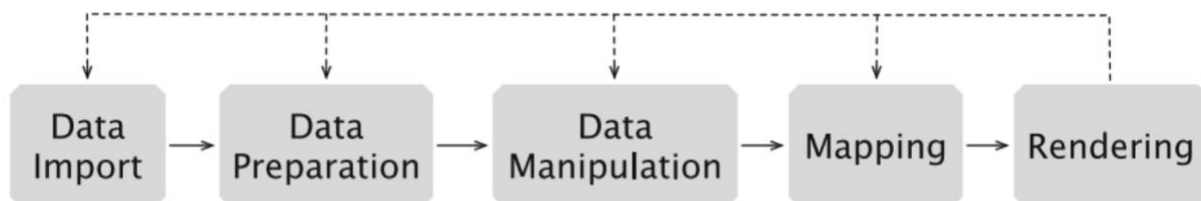
## **Data visualizations**

During the past decade the need for data visualizations increased at a rapid pace. For humans it is difficult to understand, comprehend and draw conclusions from a large dataset. Additionally, an unprecedented exponential growth in digital data has been observed during the past decades. Today computers are being used to generate graphical representations of datasets to help scientists, policy makers and other benefiting parties sense logical patterns and connections (Sadiku et al., 2016). Therefore, this improves the speed and level of understanding of the data, and helps make decisions faster. It appears to be a clear connection between the amount of newly generated data and the increased need for digital data visualizations among the scientific community. Nevertheless, it is important to mention the type of methods and different software developed and used among the community.

Data visualization methods vary based on their purpose and context. Some of the most common visualization methods include: Line graphs, bar charts, scatter plots and pie charts (Sadiku et al., 2016; Sancho et al., 2014). Moreover, different aspects of an illustration need to be taken into consideration such as visualization technique, text location, text size, patterns and colors in order to be visually pleasing and understandable (Sadiku et al., 2016). Subsequently, the computer graphics community has evolved to the point where users and engineers can choose from a variety of data visualization tools such as D3, VegaLite, VizQL and Tableau (Hanrahan, 2006; Michael et al., 2011; Satyanarayan et al., 2016; Tableau, 2018). As a result, several types data visualization methods and tools have been developed to visualize datasets, or to represent different aspects of the same dataset. Hence, it is important to think about which data visualization method and software fits the given dataset the best to have the expected outcome. Each technique has different implications, but as a general rule of thumb the following pipeline can be used to manipulate data.

### The pipeline of data visualization

When handling large amounts of data an iterative system is useful as shown in **Fig. 1**. The first step is *to import* the data from the specified dataset. Secondly, is *to prepare* the data to be visualized. This usually consists of normalization, basic checks and ordering. The third step is *manipulation*. In this step only the data that has to be visualized is selected and filtered. Additionally, *mapping* the data is the next step where it is tailored to one of the data visualization techniques mentioned above. And lastly is the *rendering* where the process is finalized and exported into a readable format (Qin et al., 2020).



**Fig. 3** The data visualization pipeline (Qin et al., 2020)

## Interactive data visualizations

Interactive data visualizations allow the users to explore and analyze data in real-time. Firstly, interactive data visualizations have an element of both exploration and explanation (Rist & Masoodian, 2022). Additionally, Ilinsky and Steele (2023) said that an interactive visualization “involves a curated dataset that is nonetheless presented with the intention to allow some exploration”. Moreover, they give the user the chance to refine and tailor the visualization based on their needs and level of understanding, thus reducing the time it takes them to understand the message (Qin et al., 2020). Therefore, interactive data visualizations can help the user reach a clear understanding by allowing exploration and by tools which shape the visualization based on their own needs. In conclusion, these tools can be indispensable for the research I am conducting, to have a larger impact concerning the expectations, and roles of both citizens and stakeholders involved in Citizen Science projects. Despite the value and benefit of interactive data visualizations the field of data physicalizations should not be omitted.

Physical data visualization is an exceptional alternative to digital data visualizations in the right context. The process can be also called *data physicalization* or a “*physical artifact whose geometry or material properties encode data*” (Jansen, Dragicevic, & Fekete, 2015). The objective of this field is to enhance human understanding of the presented data. Nevertheless, this also comes with multiple challenges. In order to develop humanly perceivable representations, novel methods need to be created to fill in the gaps between abstract and intelligible data (Dragicevic et al., 2021). Moreover, not every physical model such as “solid terrain[...], or architecture model [...]” can be called data physicalization (Dragicevic et al., 2021). Therefore, only models which house abstract scientific data can be referred as to data physicalizations (Munzner, 2008). Altogether, data physicalizations can substitute traditional digital visualizations if the conditions such as correct methods and the presence of an abstract data set are met. Overall, it is clear that data physicalizations can have a beneficial role in comprehension of information, but in the case of my graduation project a decision between a physical map, mechanical bar charts and rotating interchangeable elements needs to be made. Moreover, another level of complexity can be implemented by observing how these physical interactions can interfere with the learning processes of humans.

## **Data physicalization used for education and communication**

Data physicalizations intended specifically for educational use are crucial for a better transfer of knowledge. The presence of a storytelling element has a vital role when communicating the creators intent to the audience by directing their attention to a clearly pre-specified insight (Brehmer & Munzner, 2013; Ogawa et al., 2012). Moreover, pedagogical and collaborative decision making elements can also be present to guide the viewership into the preferred direction. Additionally, compared to analytical examples where the data is yet to be analyzed, educational physicalizations work with pre-analyzed datasets (Yvonne Jansen, 2013). Consequently, combining a pre-analyzed dataset with pedagogical elements and a story leads to a better overall transfer of knowledge. In the case of the graduation report, my aim is to raise awareness or educate people using data that has been collected and analyzed. Furthermore, to understand the human mind on a deeper level, the next topic dissects how human perception works regarding physicalizations.

## **2.4 Conclusion**

In this chapter different methods for presenting data were discussed including interactive data visualizations and surveys. There are several methods that can have a beneficial use on citizen science washing when applied, but one of them would be data physicalizations tailored specifically for educational use. This method differs significantly from the analytical and traditional data visualizations. Firstly, it reaches deeper levels of human perception, such as intermodal perception which is a combination of different senses, which leads in fact to a higher level of understanding of the presented data. Secondly, educational physicalizations rely on already analyzed datasets which can be helpful especially when the visualizations need to present pre-conceptualized messages. On the whole, the iterative process called “The pipeline of data visualization” can be applied to any of the presented methods with small changes. In conclusion, educational physicalizations came out as the first option of all the presented methods, such as interactive and traditional visualization, for the prevention of citizen science washing.

Moreover, the interview results from experts about roles of stakeholders, both scientists and citizen scientists were shown. These interviews help shaping the ideal roles of participants of citizen science projects. One of the roles as a scientist should be to inform citizens about the stage of the project and the research question. On the other hand, citizens should not be

intimidated by the researchers, and they should try to work with them together as partners where the situation allows that.

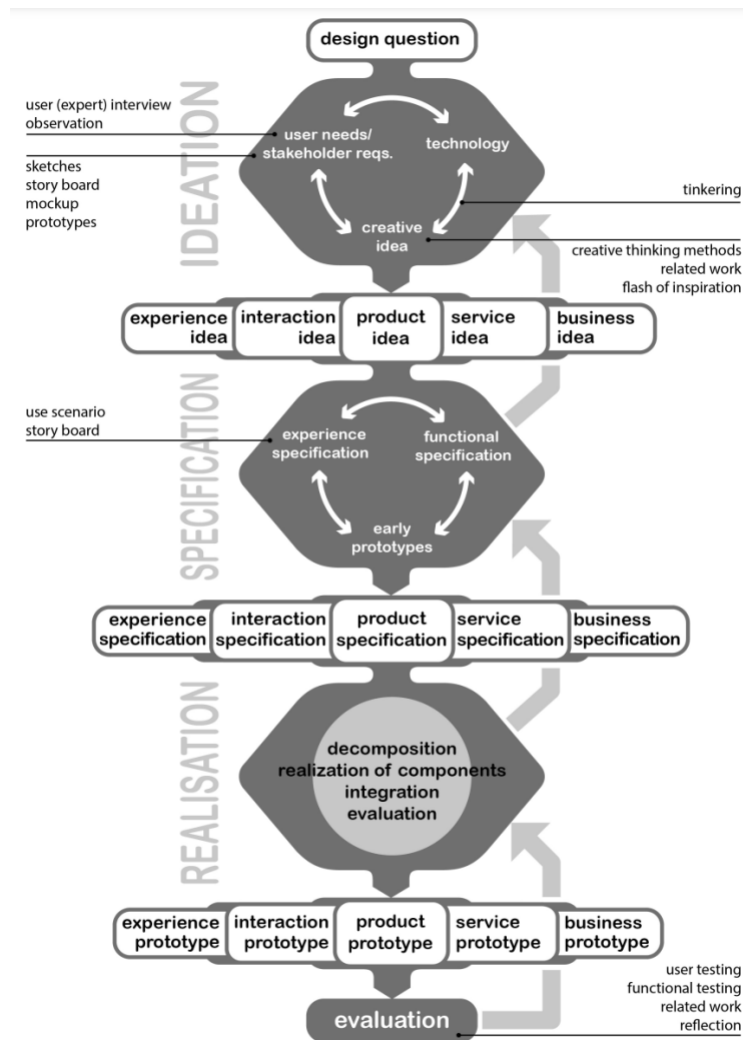
Finally, the case study I conducted was presented, consequently the concept of citizen science washing as well. It was clear that, only 32% of projects were considered “real” citizen science projects. By finding a suitable method to help citizens learn more about their roles, that proportion could be raised.

### 3. Methods and Techniques

In this thesis the Creative Technology Design Process will be used. This process is broken down to four phases: Ideation, Specification, Realization and Evaluation.

#### Ideation phase

As described by Mader and Eggink, a Creative Technology ideation phase could start with a design question or by a moment of inspiration. That can already be enough motivating force to start the process of iteration, which is also part of the second phase as shown in **Figure 3**. (Mader & Eggink, 2014). As a creative technology student I saw that glimpse in the eyes of many students while having a brainstorm session.



**Fig. 4** Creative Technology Design Process

## 4. Ideation

### 4.1 Context

For the ideation phase I choose to organize it with two of my colleagues. One of them has graduated Industrial Design Engineering and the other Management Society and Technology master at the University of Twente.

### 4.2 Brainstorm session

The brainstorm session started by me introducing the topic of my research to the volunteers and briefing them about the stage where the projects have been as well as explaining the point of the exercise. The length of the session was three hours with a small coffee break in between. We used the rapid iteration brainstorm technique where all of us had to write down a number of ideas in a limited amount of time, than continue with the best one. We used a big sheet of A2 paper with colorful markers and different colored post-its to write our ideas down. Each of us was told to use as much paper as they want to since from what I learned from my studies, brainstorm sessions should never depend on such things as saving paper or materials.

#### **First idea**

Firstly, I briefed everyone about my initial idea which was, a medium to a large briefcase which was portable, meaning, easy to travel with to citizen science related events. These can be workshops, conferences or networking events. It should be the size of a suitcase which opens up and houses the interactive data visualization. This was enough to start a creative session of brainstorming.

We decided that showing contrast by comparing the number of citizen science projects with the number of *real citizen science projects* must be the first thing to do. Moreover by having different visualizations showing differences between countries based on project fundings, SDG distributions and research areas. Moreover, also include the needs of citizen scientists which I received by conducting short interviews at a citizen science event at the university. This chart should be placed in a static position somewhere in the briefcase. Moreover one of the sides of the inside of the briefcase when open could be a laser cut map of europe with each of the

countries separately cut out with LEDs and a button placed under them, in our case only four countries would light up (the Netherlands, Spain, Lithuania and Greece) since that's where the data is from. This design would assure future expandability and easy troubleshooting. Countries could be selected when pressed and with the help of sliders different parameters could be changed such as funding in relation to different SDGs. A pie chart could be used to show more quantitative data.

## **Second idea**

The topic of *citizen science washing* is a sensitive one since it easily give the wrong message to the participants. As my supervisor Femke Nijboer said: "Shaming and judging projects who don't do "true" citizen science is not such a nice project". Since the prototype or installation should have an educational and inspirational effect we decided to brainstorm further to find a better way to educate people on how to act properly in their roles as citizen scientist.

As a result, my teammates came up with the idea to have a questionnaire that can provide some kind of feedback to the users based on their questions. Deciding on the question type, we reached the conclusion that in this case a Yes/No questionnaire should be enough since I am not interested in what they think about a specific problem, I just need to know specific aspects of their current behavior in the projects they are involved in. Moreover, it was also important to decide the means through which this questionnaire would be presented and the input methods. We thought about building the same style box for it as described in the first idea or to have it only on a laptop running as a program. The solution for the input method was left open.

## **4.3 User requirements**

The users of this tool will be citizen scientists of all age groups involved with citizen science either through projects as citizen scientists, scientists or stakeholders. This is one of the bigger challenges in this project to design something that catches attention and gives the feeling of exploration taking into consideration the large age group. They are also expected to have a medium digital literacy level. This means that clicking with the mouse and understanding the framework of the prototype should be without problems.



As described in the state of the art, data visualizations built on analyzed data can be a means of steering the conversation and raising awareness about a certain topic, in our case citizen science washing. But, also a questionnaire can raise internal questions in the mind of the participant which can lead to fruitful reflection sessions.

Users should be able to interact with it with ease and should give them the feeling of exploration while going through the process. This can be self-exploration or exploration about the prototype itself. Moreover, the design of any of the ideas should be well thought of, so users automatically go through the process without needing to ask questions or ask any guidance about the UI. (e.g. Where should I click?, What does this button do?)

### **Persona's**

1. Middle aged male who participates in citizen science projects regularly but only when his job is less stressful. The goal of this person is to find a community of people who are interested in the same topic as he is, since he is not married. He is a positive person likes action, but also has habits which are hard to change since he lived his whole life only on his terms. Since he is in his 50s and his job also requires him to learn, he has a medium digital literacy skill level. That means that answering email and using excel sheets works fine, but for more complicated tasks either more time or guidance is needed.
2. Young fresh graduate woman in her 20s with a lot of enthusiasm towards working and giving back to the community. She is part of a citizen science project as a researcher. Her tasks are to organize sessions with participants and analyze the results. She has the tendency to overwork herself which could lead to a burnout. On the other hand she is conscious about that and she uses her enthusiasm from helping others to cope with her emotions.
3. 35 year old male, living in a Dutch village where pollution is a major issue. His main motivation to be a citizen scientist is to prove the local government that the pollution needs to stop for environmental reasons. On the other hand many of his neighbors depend on the industry which causes the pollution. Because of this, sometimes he does not know which side to take.
4. 68 year old male, recently retired, but still very active and interested in environmental factors. He has a lifetime of experience working on scientific projects since he worked as

a lab technician at the university for 41 years. His expertise are more than welcome, but he requires guidance when working with technology. Nevertheless he is fully motivated to develop a medium digital literacy level by joining a citizen science project.

## 4.4 Final concept

Choosing between the two ideas is a difficult task. Both have their pros and cons, so as a helping tool, I decided to use the How-Now-Wow matrix.



**Fig. 5** How-Now-Wow matrix

In my case, the first idea was placed in the How box, since it has a lot of potential, but it was decided to skip this idea from ethical reasons, more on that later. It is challenging since information about money and misplacing money is difficult to present with an installation which should provide guidance and raise motivation. It can easily have the exact opposite effect. For this reason I decided that the questionnaire which provides feedback to the user can act more as a game-changer than the toolbox with the data visualizations. That's why it is placed in the Wow box.

### **Moral problem statement**

Can I present citizen science washing in a direct way through an installation without giving the wrong impression? By this I mean without shaming citizen science projects?

Moreover, there was also a moral question in my mind when pursuing this path. Is this really the topic I want to build my bachelor graduation project around? As my supervisor said, this topic could have been a nice one only as a research paper, but not building a prototype around it.

*Briefcase:* the benefits of option A are the clear motive of the installation. It should be obvious after interacting with it that citizen science washing is a problem and something needs to be done about it. On the other hand, the clear motive is one of the downsides as well. Since it is so clear, it is easy to frame it negatively as well. This option is in line with virtue ethics moral theory, since the actions are not necessarily important but the outcome. And this prototype has a positive beneficial goal.

*Questionnaire:* This option is not as clear about citizen science washing as option A, but it has the element of curiosity and engagement introduced by the personalized advice. That can give the user an urge to finish it so they get something personalized. Moreover, the decision for this option would be made by utilitarian perspective, since in this case I am considering all of my direct and indirect stakeholders, and I act in a way that everyone benefits from it. For the greater good, even if my point is not as clear as I imagined.

This is the moral reason that contributed towards the decision of choosing the second option.

The final product should be a questionnaire which can be shared at citizen science related events. These can be workshops, conferences or networking events. The UI should be partly physical and partly digital with only a few inputs so it is more straightforward and easier to use by everyone.

Moreover, the prototype could act as a conversation starter, but not sharing too much information, so people won't get overwhelmed. This would also help keep the curiosity active of the participants. However, in order for this to happen the accompanying person needs to be a truly knowledgeable person on the topic to be able to transmit a message with the help of the questionnaire.

## 5. Specification

In this chapter the initial requirements for the concept will be presented. Since I am also involved in currently active citizen science projects at the University of Twente, at one of our weekly meetings I told the idea to my colleagues to ask for feedback about the initial concept described in Chapter 4.4. Since this group of people were all researchers participating or leading citizen science projects, it was the best crowd for asking for fast feedback about my concept's requirements. It also helped that they were already acquainted with the topic I was researching.

This exercise revealed that the second idea is preferable over the first one for the same moral reasons explained previously in Chapter 4. They also suggested to build a tool which is available online since all the tools that they have been using in the past needed to be adapted to digital during Covid-19.

Other than the previous session, I had a meeting with my main supervisor Femke Nijboer and critical observer Epa Champika Ranasinghe as well to brainstorm on how should the prototype work and look like. I especially asked Femke because I knew that she is also a citizen scientist and could provide me with valuable feedback. They suggested that it should be more than a questionnaire, more like a service/multi-use tool. This meant that there should be a way to contact the participants by asking for their email address at the end section of the tool. This could be for the reason for a follow up or for further contact. Moreover, they also suggested to introduce an element of gamification in it such as a title which fits each advice (eg. "You are an ACTIVIST..."). Since the email address should be stored somewhere I need to think about a solution for that as well. Otherwise there is no point for asking for them if the data gets deleted after the browser session is closed.

By organizing these two sessions I had enough information on how to advance further with the idea for my prototype:

The prototype should be a questionnaire/tool made as an adaptive webpage which can run on any device that has internet connections, since it should be a webpage. Ideally it should store

the email of the users, but no other information. This could be achieved by using phpMyAdmin database management system.

A feedback questionnaire form should be on the thank you page which asks several questions about the prototype itself after completion. The advices at the end are based on the 5 personalities inspired from 16 personalities as well (*16 personalities*, 2013).

Functional technical requirements:

- It is a web-based questionnaire which runs on PC and Android/iOS
- 8 YES/NO questions one after each other
- It should give a personalized advice based on the answers to the questions
- 5-7 pre-written advice pages with specific personalities
- Runs on local network
- Internet connection

Non-functional technical requirements

- Adaptive good looking UI (PC/Phone)
- User-friendly UX/UI
- To use the language requirements in the scientific field (citizen science in this case)

For the next section I will use the well-known MoSCoW method which introduces a four step approach for the project requirements. The goal of these steps are to prioritize different aspects of project requirements. The MoSCoW method identifies project requirements that are necessary for the completion of the project, that should be included to reach the goals, requirements that could be nice but they are negligible from the goals perspective and finally requirements that are not a priority within the projects timeframe. (Brush, 2023)

# MoSCoW prioritization



Figure 6. MoSCoW method (Brush, 2023)

## The application of the MOSCoW method on my project

### 1. Must have

- 8 questions
- Personalized advice at the end
- Logic for calculation based on answers
- Emailing system. This system should send the winning advice directly to the participants email, which was gathered through a form.

### 2. Should have

- Appealing UI
- Good color selection for buttons and background
- Greeting Message and "Thank you!" section
- Consent form included at the beginning

### 3. Could have

- Could be game-changing if it could be accessed from anywhere on the internet
- MySQL database where the answers are saved for potential further research

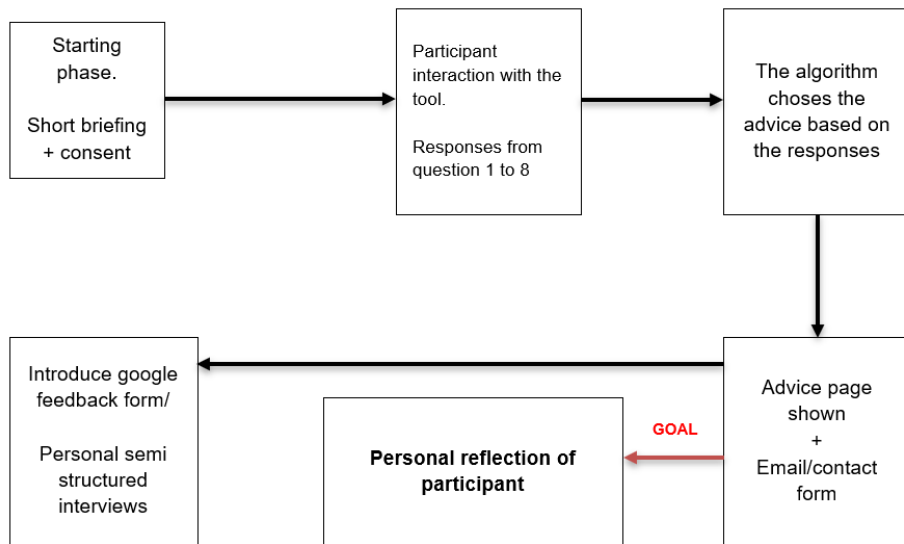
- Progress bar for questions
- Adaptable to mobile screens and PC screens flawlessly
- A feedback google-form on the experience and questionnaire located on the thank you page.
- Questions that can be answered using a Likert scale and not only Yes/No questions

4. Won't have

- Custom domain to increase trust like <https://www.cs-questionnaire.com/>
- Google workspace
- Implemented AI for the logic/decision making (for future reference)

The system should feel intuitive for the user, with aim of empowering them to reflect on their roles within the citizen science project. The questions should be constructed in a way that it is reflective to the tasks and responsibilities that need to be filled in within a project, so the users can empathize with it. During the interaction with the tool, the users should feel empowered and values for their work in a citizen science project. The role of the tool should be to make the project member better understand how can they shape the project outcomes with better engaging in their roles, with a potential effect on the amount of misinformed project fundings.

Down below you can observe the Abstractization and flow of the project system. This is how I imagine the system to be used and interacted with.



**Fig. 7** Abstractization block diagram

## 6. Realization

The final prototype is based on 8 questions. The users need to read them and provide an answer based on the roles they fill in within a citizen science project they are part of. The questions resemble in the format of Yes/No questions, because the level of complexity of the tool has to be according to citizens as well, not only scientists. You can read the questions below:

1. Does your project include citizens by informing them about the research question and direction of the project?
2. Do citizens have a voluntary role?
  - a. “By this question I mean, are they compensated or are they doing it out of passion.”
3. Does your project include citizens in the co-creation process?
  - a. “Are citizens included as stakeholders, part of the quadruple helix (governance, industry, academia and citizens)?”
4. Do citizen scientists benefit in a similar way as scientist do from the project outcome?
5. Have you provided feedback or suggestions to the project organizers/team to improve the overall experience for citizen scientists?
6. Did you receive sufficient guidance and training to effectively contribute to the project as a citizen scientist?
7. Are citizens acknowledged in the project results and publications?
8. Are you generally content with the progress and overall experience of the citizen science project you are currently involved in?

These questions are carefully selected and constructed based on the 10 principles of Citizen Science, formulated by the European Union. I also based the questions on the findings from the interview sessions I conducted beforehand (ECSA, 2015). The aim of the questions is to assess how well are roles fulfilled in a citizen science project, moreover to provide tailored advice to the user based on their answers.

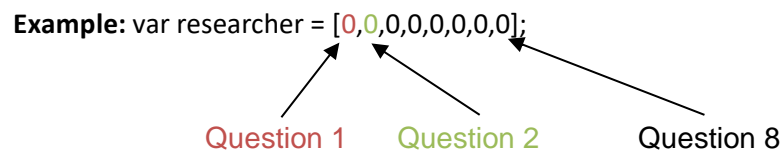
### **The underlying algorithm of the tool**

Based on the input of the users, the algorithm chooses one of the 5 advices, which later on pops-up for the user. The algorithm was written as a web-based questionnaire with the intent to be used both on PC and mobile devices. This way, the accessibility of it is also higher compared to



a windows only form based questionnaire. The tool is constructed with the help of different programming languages. The overview of the languages used can be found below:

- HTML was used to create the web pages for each question, welcome screen, thank you page and all the advice pages
- CSS was used to format these pages to be pleasing to look at and to make them adaptable to mobile screens
- JavaScript was used to create the logic behind the algorithm and to store the values between the different webpages since no database management system is used to reduce complexity
- PHP was also used to send out the personalized emails to the users who completed the questionnaire. This was possible with the SMTP protocol and through port 587.



**Fig. 8** List algorithmic logic

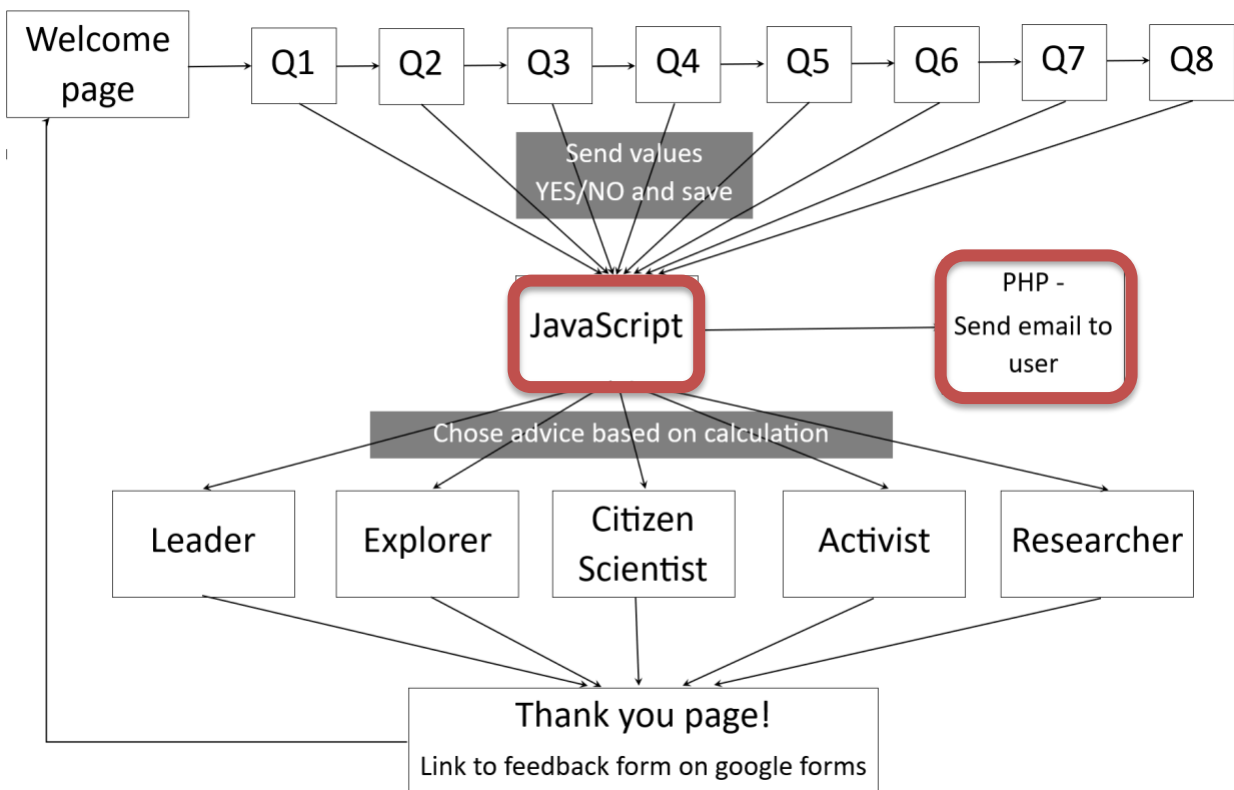
**Figure 9.** below shows a schematic how the advice is given based on the answers from the questions. Green color (YES) for the question means a positive advice for the personality type, and red color (NO) is negative advice for the personality type. If the participant chooses YES for question 3, see **Fig. 9** , then the value representing this question (index 2 in this case, **Fig. 8** ) within the arrays “Leader” and “Citizen Scientist” will be incremented with a number between 1 and 5. This value is subjective and it is still being developed and perfected for a better overall balance.



**Fig. 9** Question map

The points of this array are summed at the end of the eight questions and compared to the scores of the other personality types. Based on an algorithm which is still being balanced for the best outcome, the personality type with the most points is chosen to be the “winner”. This personality type with the assigned advice is presented to the user at the end of the questionnaire.

## Diagram of decisions and flow of the program



**Fig. 10** Diagram of decisions and flow of the program

The diagram (**Fig. 10**) above represents the flow of the program coding wise. All the rectangular boxes represent separate HTML webpages (Q1 → Q8, Leader, Explorer, Citizen Scientist, Activist, Researcher, Thank you page, Welcome page). The two red curved rectangles represent two files which contain the logic explained above. The PHP file is linked to the JavaScript file and its only role is to send an email when requested by the user. All the code can be found in the Appendix.

These are the five types of advice which are categorized by a five different personality types:

1. Leader/Protagonist

“Give a good example to the other participants in the projects. Your way of thinking and tackling problems can have a positive impact on the project and the team dynamic. A good team is half success. Flexibility needs to be one of your strengths but also

weaknesses. Recognize new opportunities, but be skeptical at the same time. Trust people but don't be blind. Take care of yourself and set boundaries to avoid burnout. Collaborate with others to amplify your efforts. Your empathy is a strength, but remember to avoid taking on everyone's problems. Stay focused on your goals and the project goals and make a positive impact by inspiring others."

## 2. Logistician/Researcher

"As a Researcher, you possess skills that are crucial when working on a research project. Be a guide to citizens by advising them with good practices about data collection and data analysis. Be flexible and keep in mind that your work colleagues might not possess the same skills and experience you have. You possess admirable qualities such as honesty, integrity, and a strong work ethic. Your sense of responsibility and loyalty make you a reliable contributor to any project. Your preference for clear guidelines and structured environments allows you to excel in managing tasks effectively. While you value established rules, try to be flexible in unstructured environments. Avoid being judgmental towards those who hold different viewpoints"

## 3. Activist

As an activist you have strong viewpoints on several aspects of the project. Many times this quality you possess is the breathing heart of the team. Nevertheless, it is also easy to hinder the progress of the project by ignoring others perspectives and viewpoints. Engage with diverse perspectives, build alliances, and inspire others through your actions and words. Stay resilient in the face of challenges, understanding that progress takes time. Remain open to alternative viewpoints and be willing to adapt your strategies for greater effectiveness. Your determination to make a positive impact is invaluable, so keep pushing forward with empathy, courage, and a belief in the transformative power of your work."

## 4. Citizen Scientist

"As a citizen scientist, you have the incredible opportunity to contribute to scientific research and make a meaningful impact inside the project you are involved in. Embrace your curiosity and passion for exploration, and never underestimate the value of your contributions, no matter how small. Stay curious, continuously seek new knowledge, and engage with the scientific community to enhance your understanding. Collaborate with

fellow citizen scientists and scientists, sharing your experiences and insights to foster collective learning. Be the glue that holds the team together when times are difficult. Moreover, keep in mind that you can be the bridge which connects multiple disciplines within your team. Embrace challenges as learning opportunities, adapting your approaches and methodologies as needed.”

#### 5. Adventurer/Explorer

As an explorer, your curiosity is one of your biggest strengths. By being curious you are always seeking for the unknown and by that helping the team and project progress in uncharted territories. You should keep in mind that curiosity can be one of your biggest weaknesses as well. Find a balance that allows you to express your independence while meeting project requirements. Nurture your curiosity and desire for exploration, as they can lead you to new insights and perspectives. Leverage your artistic abilities to communicate your ideas effectively, capturing attention and evoking emotions. However, be aware of potential challenges, such as a preference for freedom and spontaneity over structured plans. Your natural charm and warmth make you likable and popular, enabling you to build harmonious relationships with others.

These five pieces of advice were written with the help of the tool called ChatGPT from open AI. This tool helped to summarize positive and negative character traits from the website called 16 personalities (*16 personalities*, 2013) and then the algorithm I have written assigned them to people the corresponding people. Through these personality types an element of gamification is introduced. This way the participants are further challenged to reflect on their roles. Furthermore this element can also increase the curiosity and motivation level of the users.

Right now the AI tool is only used to help create the advices, however in the future it could replace the algorithm entirely, and make the decision process smoother and more accurate.

Down below you can see two example pictures taken from the website. Figure xx represent question 1 and figure yy represents the “Researcher” page with the corresponding advice. Moreover the email input form and the google feedback for hyperlink can be also observed.

Does your project include citizens by informing them about the research question and direction of the project?

Yes No

**Fig. 11** Question 1 from Reflecto-tool

**Congratulations! You are a Researcher!**

As a Researcher, you possess skills that are crucial when working on a research project. Be a guide to citizens by advising them with good practices about data collection and data analysis. Be flexible and keep in mind that your work colleagues might not possess the same skills and experience you have. You possess admirable qualities such as honesty, integrity, and a strong work ethic. Your sense of responsibility and loyalty make you a reliable contributor to any project. Your preference for clear guidelines and structured environments allows you to excel in managing tasks effectively. While you value established rules, try to be flexible in unstructured environments. Avoid being judgmental towards those who hold different viewpoints.

Enter your email address if you would like to get this advice in your inbox as well!

Submit

By submitting your email you agree to receive a follow-up email with the same advice within a week. I am offering this as a service for the time of my graduation project, so if you have any questions about the advice, citizen science or my project feel free to email me at [a.krivosik@student.utwente.nl](mailto:a.krivosik@student.utwente.nl)

Ahh, I don't need an extra email, fill in feedback form instead!

Finish and fill in feedback form!

**Fig. 12** “Researcher” advice page

Lastly, like mentioned before the PHP script is responsible for sending out emails. As you can see in **Fig. 12** there is an input field for an email address. If participants submit their email address, the tool can send them a reminder email about their advice they received after a week.

This function can also be used to get in touch with the participants for citizen science related support or questions. Further down you can also see my email address

*a.krivosik@student.utwente.nl* which is present to give the participants the option to contact me (in this case) for further questions. Optimally, contacting me, or the respective person, should be possible by replying to the remainder email. But, in the case people do not want to submit their email, they will not receive any emails from the tool, so they can use the provided email address to get in contact.

# 7. Evaluation

## 7.1. Evaluation focus

The focus of my evaluation is to help the participants reflect on their roles within the citizen science project they are participating in. The goal is the same both for researchers and citizens, but the type of reflection should differ based on the title.

In the bigger picture, the decision for this topic came from the results from the case study of the four countries, I conducted earlier. That introduced the concept of citizen science washing, a concept not easy, and more controversial to tackle, which led me to the question on how would it be possible to make a positive impact on citizen science projects and their members to avoid similar scenarios as this one. The advise contain best practices for the assigned personality type and include parts about weaknesses as well. These advise are updated between separate evaluation sessions accordingly based on the feedback received.

Further below I list three aspects that are relevant for my tool: effectiveness, efficiency and satisfaction which will be measured during the user evaluation:

### **Effectiveness**

In the case of the Reflecto-tool users should be able to finish the questionnaire by reading the 8 questions and answering them. It is important to mention that between questions participants should also take some time to reflect on their current roles and past behaviors within the project they are part of. Moreover, the tool should urge them to be more proactive and considerate when exercising their citizen scientist roles.

I would also like to measure the reaction and motivation on how users react to the advice they receive. Does it help them, or motivate them to do something differently or better? Moreover, I would like to observe how do participants react to the gamification element included through the five personality types. I would also like to measure what proportion of users are interested or willing to submit their email address to receive the advice there as well. This measure could indicate the importance of the advice they received. In the case they do not want the email, they might not be that interested in the educational advice.



## Efficiency

In terms of efficiency, I would like to measure how does the UI and overall design of the tool effect the level of understanding of the participants. If changing the looks, questions or basic mechanics of the tool leads to an easier usability level, than I would like to know about it to improve it between sessions.

## Satisfaction

I would like to measure the importance of the email input form here as well, but from a different perspective. I would like to know if users appreciate the option or not. Does this option raise the tool to “another level” compared to similar tools, or it has no importance. Moreover, since this is multi-use tool I would like to measure how do users react to the information they receive and to see if they find it valuable or not. Useful or not.

## 7.2. Evaluation approach and methods

The user evaluation is broken up into two separate events. Firstly, the tool will be sent out to multiple citizen scientists through email. Since I was already working on citizen science projects I had contacts to send it to. Moreover, my supervisor also shared it with her own network of citizen scientists. Other than that, with the help of Citizen Science Hub Twente I was able to reach even more interested parties.

This session will provide me initial feedback about the newly built tool, which I will implement before organizing the second in-person evaluation session.

The feedback from the first session is collected through a google form connected to the “Thank you page” (**see chapter 6, Fig. x**) containing the following questions:

1. Do you see yourself as a citizen scientist? effectiveness
2. What do you think of the advice you got? How did it make you feel? effectiveness
3. What do you think of the length and appearance of the tool? Efficiency,
4. Did any of the questions make you reflect on the design of your project? Which one and how? effectiveness
5. What questions should we have asked? efficiency
6. What do you miss form the advice? How would you change it to be more helpful?

efficiency

After the sixth question a 7<sup>th</sup> question will pop up asking the user if they want to receive my thesis through email when its finished. They can either submit their email address or skip the question.

Since this first session was organized in an online environment there was no place to ask for verbal or written consent. That is why the start page of my tool contains a consent form which they need to accept in order to start using the Reflecto-tool (**see Appendix consent form**).

For the second evaluation I would like to invite multiple (ideally at least 8) citizen scientists for a live session. This session will take place at the University of Twente at the ITC faculty. It is relatively difficult to find citizen scientists and to also invite them at the same time to the same place. Because of this I will try to organize this session after an event about citizen science.

I plan to set up a round standing table with two laptops and an A4 paper with a QR code leading to the tool. Participants will be briefed about the topic of my research and asked to consent to participation either through the same procedure as in the first session, or on paper format which I provide to them. After these I will invite participants to consecutively try out the tool, which houses the implemented feedback after session one. During the session I will not interfere nor ask the participants questions, only observe their reactions a behavior form a distance. After the session participant will be asked to form a circle around me or the table and in a focus group setting provide me feedback. The question I will ask are the same as for the first session, but the interview will be semi-structured, so there is space for additional remarks, which I am looking for.

The result will be combined with the results from the online session and conclusions will be reached to improve the current tool.

It is important to highlight that different participants will be chosen for the two sessions. The option to retry the tool for participants is always there by submitting their email on the “Thank you page”.

## 7.3 Results of evaluation

In this section I will evaluate the results from the user testing session based on the focus points listed in **chapter 7.1**.

As an overall focus of my evaluation is the amount of reflection made by the participants. It is measured by the focus points listed below, measured at the first and the second evaluation session:

### **Feedback received towards each focus point**

#### **Effectiveness:**

Measuring the effectiveness of my tool was based on the questions of “Do you see yourself as a citizen scientist?”; “What do you think of the advice you got? How did it make you feel?” and “Did any of the questions make you reflect on the design of your project? Which one and how?” of the feedback form. Generally, there is still some confusion regarding the differences between actual citizen science projects and projects that involve citizens in a way, therefore asking the question of “Do you consider yourself a citizen scientist” was important in this case to see where the participants of the user evaluation position themselves. 77.8% of the respondents consider themselves being citizen scientists, while 22.2% responded no to this question. The feedback of the participants on the advice they got was generally a positive one, the majority of them stating that they felt confident and motivated after reading it. They also stated that it helped them better understand the position they are supposed to take in the project, based on their role, one of them highlighting in particular that they felt “relieved” after getting the advice that they should not overfocus on the structure and planning of their project. These answers already indicate the effectiveness of the advice that is being provided after the questions has been answered. There has been a slightly more negative feedback as well, drawing my attention on the fact that some people might not perceive the advice useful, however it was only one response.

The answers for the question if the tool made the participants reflect or not, calls for improvement of the tool, because the majority of the responses stated that in general the 8 questions of the tool have been too vague to be able to go deep on reflection. Some of the participants also highlighted that they were not sure about what project to base their reflection on, or they thought that not all the questions of the tool are applicable for their projects. The fact that the questions has been constructed too vaguely, also made participants hesitant about the answer they should provide for it, which is another important learning outcome of the user testing. Regarding the questions that made them reflect the most, multiple people assigned

success to the one that asks them if the citizens in their projects engage voluntarily or not. Participants stated that it really made them reflect on the role of the citizens in their projects, even in cases when they have been working on it for quite some time already. Based on the presented input, the tool can be considered effective because it reaches the effects it intended to have in the participants. By engaging with the tool, participants have been incentivized to reflect both on their roles and the roles of the citizens involved in their projects and they also received guidance about how to exercise their role. The majority of the participants indicated that the advice they got was also motivational and informative and 5 of the 8 participants of the user tasting signed up for future emails as well.

### **Efficiency**

In terms of efficiency, I was focusing on the appearance and the user experience of the tool. In the user evaluation, I asked people to provide their opinion regarding the length and the appearance of the tool. The length of the tool has been appreciated by the users and they stated that having only 8 questions makes it accessible for everyone. In terms of improvements in the user experience I received very valuable insights such as the need for some preliminary information, which makes them understand the aim of the tool and that they should choose a representative citizen science project they worked/ are working on for reflection purposes. They also suggested to include an indicator under each question that shows the participants how many steps are left until the completion of the exercise. The reason for this is that it helps them understand the process of reflecting on their role and project better. Another valuable feedback was the expansion of the types of responses that can be provided for each question. Multiple users highlighted that some of the questions require a different type of answer than Yes/No only and it would be useful to introduce at least a Likert scale. Besides different answers that can be provided, the questions could also be made more specific, with more explanation on the side about which aspect of their project should they think of. As a suggestion for additional questions or input possibilities the participants said that it would be useful to allow them to provide a short description on the project they chose to reflect on. This would help them to get in the mindset of reflection and potentially have a more accurate outcome of the role they have been taking. Furthermore, they also said that asking about the intention of the scientists and the goal of the project they have been working on could be a nice addition to the tool, however that might bring in a different functionality already, besides giving the personality advice. In terms of how efficient people found the tool educating them about their roles, the user evaluation highlighted a very important aspect of it. For the users who are established citizen scientists and have been

working in the field for years it doesn't seem to be as efficient as for the users who are just getting acquainted with working on citizen science projects. This advice from the participants of the user testing helps me position the tool in terms of what is the use case where it can produce the most helpful outcome with making the participants reflect.

Lastly, several participants also mentioned that dividing the tool into two parts (scientist and citizen) would create a better level of engagement. Currently not all questions fit both roles the same way, meaning that some questions are only valid towards citizens and not researchers (e.g. Did you receive sufficient guidance and training to effectively contribute to the project as a citizen scientist?).

### **Satisfaction**

As a final question of the evaluation session I also asked the participants if they would be interested in trying a second iteration of the Reflecto-tool, after I reimplemented the feedback I got from them. 57% percent of the respondents indicated that they would be interested in hearing about it again, which means that they appreciated the feedback they received after answering the questions. This shows some level of satisfaction with the Reflecto-tool, however there is room for further improvement in this case.

## 8. Discussion and Conclusion

### 8.1 Discussion

In this chapter the relation between the results and the main research question will be discussed. As a reminder, the aim of the study, defined also by the research questions is to find suitable methods to guide and help citizens reflect on their roles. As a result the occurrence of citizen science washing should be decreasing. That is the main goal, even though the impact on citizen science washing is not measured, since it is out of the scope of this graduation thesis. The data gathered through the evaluation sessions suggests that the Reflecto-tool does in fact influence the level of reflection of the participants. As written in **Chapter 7.3**, participants stated that it was motivating to read the advice, and that the questions made them think about their roles which is in concordance with the goal of the research question. Furthermore, to answer the second sub-question: *What are the roles of citizens and stakeholders?*, one of the participants stated that the tool made them feel “relieved” after getting the advice that they should not overfocus on the structure and planning of their project: *“and I was particularly “relieved” to read about things being in flux and me not having to overfocus on structure and planning”*.

The results from several respondents also suggested that there should be clear distinction between the questions designed for researchers and the question designed for citizen scientist. Similar suggestions were made also in the interviews conducted with experts on citizen science (see **Chapter 2.2**). This is important to mention because I conducted my evaluation with participants from the academia (academic environment), and that already suggests that their roles differ from the roles of citizens. Moreover, questions as “Do citizens have a voluntary role?” does not concern the researcher since they are definitely compensated if they exercise their scientist role within the project. This also shows that the research question could be broken into two separate parts where the focus is on researchers and/or on citizens.

From an effectiveness standpoint, participants also stated to have different types of options to answer the questions. Instead of having only YES/NO questions the option NONE and BOTH could be added as well. Furthermore, using a Likert scale or text input fields would further advance the amount of reflection and thinking depth. On the other hand, the usage of these methods can influence the efficiency level of the tool, since most participants were happy about

the length and complexity. By adding more options and lengthening the required time for completion, satisfaction and quality could be lost. Lastly, this could be compensated by adding a progress bar as suggested by several participants “It can be better if you provide an indicator about how many steps left, otherwise it is difficult to understand how many questions we will receive.” which could indeed balance out the tool.

But how does this connect to citizen science washing at all? As suggested in the literature in **Chapter 2.3** citizen science washing can be a means to deceive the more conscious crowd as the example shows about “greenwashing” and “brainwashing”. With the help of this tool, the target crowd to be deceived can already have a better understanding on how things should work in a citizen science project on a general level. This does not mean that the tool directly impacts citizen science washing, but that it contributes to the level of understanding of participants to avoid this from happening in the future.

Last but not least, participants suggested that they would find the Reflecto-tool useful within their projects as an internal tool. This means that the ease of changing the questions and the advice could lead to a widened use case map for the tool, which I did not intended at all. Nevertheless, it is easy to see why this would be a great use case. By customization, stakeholders could tailor the tool based on their own challenges and by that raising the reflection level and consciousness level of citizen scientists even more, which is clearly related to the research question.

Lastly, I would like to mention that 57% of the participants submitted their email address to try out the last iteration of the Reflecto-tool, which shows the tool in fact had an effect on their perception and engagement level, which led them to sign up for the next iteration. I think this number could be raised by applying the feedback discussed earlier, but I also find it half success now.

## 8.2 Conclusion

In conclusion, the results from the Reflecto-tool are aligned with the research question. With building the tool it became possible to help users think about and reflect on their roles within citizen science projects they are participating in. Even though the tool was designed with a general use case mindset, different actors such as scientists and citizens could both benefit from it. During the interviews and evaluation session crucial information was gathered which helped to reiterate the prototype, but also gives a roadmap for further development of the tool. Either to make it work as an internal assessment or coaching tool, or as a general awareness raising tool intended to be used at networking events. One of the limitations worth mentioning is that the current state of the tool does not allow for different input methods other than YES/NO questions, and in order to change that the base algorithm responsible for the calculation has to be retaught and rewritten from scratch.

## 8.3 Future work & Recommendations

One of the next steps would be to define indicators which could measure the impact of this tool on citizen science washing. Currently there is no option to measure that, and one of the reasons could be that citizen science is an emerging field and currently is hard to even keep track of the projects that are happening in different countries. Other difficulties include the selection of a project pool and the definition of indicators. Furthermore, measurements could be made on a periodically reoccurring framework such as the Horizon 2020 program or similar, where additional bias factors introduced by the lack of structure or flawed methodology are already excluded.

Several responses suggested that the tool was not useful to them since they are involved in citizen science projects for a long time. This information is particularly useful when choosing the target population for the Reflecto-tool. The current research question does not specify the expertise level of the participants, but for future references that could be changed to make the tool more effective.

Furthermore, as mentioned in the **discussion chapter**, creating a user friendly UI where questions, type of question, number of questions and changeable advice could lead to further use cases for the tool. This would need further development of the code found in the **Appendix**.



As mentioned in the conclusion, to implement different question types the algorithm needs to be redesigned. As a future recommendation, for better results and more accurate advices the API from chatGPT Open AI could be implemented within the code.

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# Appendix

## Consent form

### Participant information letter

Date:

This research is about citizen science. Several aspects of your understanding will be measured.

#### **Why have I been asked to take part?**

You are the perfect candidate to be a participant in my research since you fit the all the predefined criteria. In this case being a scientist or citizen scientist.

#### **What will I be asked to do?**

You will be asked to interact with a prototype and follow instructions. Between these instructions questions will be asked which you will need to answer.

#### **Are there any risks involved?**

I perceive there will be no risks or side effects from this study to you as a participant.

#### **Will anyone be able to identify me and the things I said?**

All information obtained will be confidential and will be kept anonymous. All information collected will be treated with the strictest confidence and data will be stored safely. Furthermore, no personal identifiable information (PPI) will be collected.

#### **What will happen to the information?**

The information will be used to complete my evaluation session for my bachelor thesis at the University of Twente.

#### **If I don't want to take part can I say no?**

If you do not want to take part you are able to say so, if you start to participate but then decide to withdraw you are able to do so with no detrimental effects.

#### **If you wish to participate what do you do next?**

Sign and date the consent below.

I agree to take part in the research described above:

Signature: .....

Date: .....

## HTML code

### Start html

```
<!DOCTYPE html>
```

```
<html lang="en">
```

```
<head>
```

```
<meta charset="UTF-8">
```

```
<meta name="viewport" content="width=device-width, initial-scale=1.0">
```

```
<title>Research Participation Consent</title>
```

```
<style>
```

```
body {
```

```
display: flex;
```

```
flex-direction: column;
```

```
justify-content: center;
```

```
align-items: center;
```

```
font-family: Arial, sans-serif;
```

```
background-color: #f2f2f2;
```

```
margin: 0;
```

```
padding: 20px;
```

```
text-align: center;
```

```
}
```

```
h1 {
```

```
font-size: 24px;
```

```
font-weight: bold;
```

```
margin-bottom: 20px;
```

```
}
```

```
p {
```

```
font-size: 16px;
```

```
margin-bottom: 10px;
```

```
text-align: justify;
```

```
}
```

```
.signature {
```

```
margin-top: 20px;
```

```
font-style: italic;
```

```
}
```

```
button {
```

```
background-color: #4CAF50;
```

```
color: #fff;
```

```
border: none;
```

```
border-radius: 4px;
```

```
padding: 10px 20px;
```

```
cursor: pointer;
font-size: 16px;
transition: background-color 0.3s ease;
margin-top: 10px;
text-align: center;
}
```

```
.question-container {
background-color: #fff;
border-radius: 10px;
padding: 20px;
margin-bottom: 20px;
box-shadow: 0 2px 6px rgba(0, 0, 0, 0.1);
text-align: center;
display: flex;
flex-direction: column;
justify-content: center;
align-items: center;
}
h3 {
font-weight: normal;
}
}
```

```
</style>
</head>
```

```
<body>
```

```
<h1>Welcome to the Reflecto-tool!</h1><br>
```

```
<h3>This tool will help you shape your role in a citizen science project. Whether you are a stakeholder or a citizen scientist, it works for both.<br>
```

```
Press start to begin with your journey of becoming a conscious citizen scientist.</h3>
```

```
<h3>This tool is developed as a part of my graduation project under the supervision of <b>Femke Nijboer, Champika Epa Ranasinghe</b> and external advisor <b>Maya van den Berg</b>. It is meant to provide tailored educational advice to you about your role in the citizen science project you are participating in.</h3>
```

```
<div class = question-container>
```

```
<p><strong>Why have I been asked to take part?</strong></p>
```

```
<p>You are the perfect candidate to be a participant in my research since you fit all the predefined criteria. In this case, being a scientist or citizen scientist.</p>
```

```
<p><strong>What will I be asked to do?</strong></p>
```

```
<p>You will be asked to answer the upcoming questions. After that you will be redirected to a feedback form where I ask you to provide feedback on this tool.</p>
```

```
<p><strong>Are there any risks involved?</strong></p>
```

```

<p>I perceive there will be no risks or side effects from this study to you as a participant.</p>
<p><strong>Will anyone be able to identify me and the things I said?</strong></p>
<p>All information obtained will be confidential and will be kept anonymous. All information
collected will be treated with the strictest confidence and data will be stored safely.</p>
<p><strong>What will happen to the information?</strong></p>
<p>The information will be used to complete my evaluation session for my bachelor thesis at the
University of Twente.</p>
<p><strong>If I don't want to take part can I say no?</strong></p>
<p>If you do not want to take part, you are able to say so. If you start to participate but then
decide to withdraw, you are able to do so with no detrimental effects.</p>
<p><strong>If you agree and wish to participate, what do you do next?</strong></p>
<p>Press <b>START</b> below!</p>

```

```

<div>
  <a href="question1.html">
    <button>Start</button>
  </a>
</div>
</div>
</body>

```

```

</html>

```

### Question 1

```

<!DOCTYPE html>
<html>
<head>
  <title>CS questionnaire</title>
  <link rel="stylesheet" type="text/css" href="style.css">
  <meta name="viewport" content="width=device-width, initial-scale=1.0">
</head>
<body>

  <div class="question-container">
    <h2>Does your project include citizens by informing them about the research question and
direction of the project?</h2>
    <br>
    <div class="button-container">
      <button onclick="answerYes()">Yes</button>
      <button onclick="answerNo()">No</button>
    </div>
  </div>

  <script src="script.js"></script>

</body>

</html>

```

## Advice 1

```
<!DOCTYPE html>
<html>
<head>
  <link rel="stylesheet" type="text/css" href="adviceCSS.css">
  <meta name="viewport" content="width=device-width, initial-scale=1.0">
  <title>Questionnaire</title>
</head>
<body>
  <h1>Congratulations! You are an <b>Researcher!</b></h1>

  <div class = advice>
    <p>
      As a Researcher, you possess skills that are crucial when working on a research project. Be a
      guide to citizens by advising them with good practices about data collection and data analysis. Be
      flexible and keep in mind that your work colleagues might not possess the same skills and
      experience you have. You possess admirable qualities such as honesty, integrity, and a strong
      work ethic. Your sense of responsibility and loyalty make you a reliable contributor to any project.
      Your preference for clear guidelines and structured environments allows you to excel in managing
      tasks effectively. While you value established rules, try to be flexible in unstructured
      environments. Avoid being judgmental towards those who hold different viewpoints.
    </p>
  </div>

  <form id="myForm" method="POST" action="sendEmail.php">
    <p class="email_text">Enter your email address if you would like to get this advice in your inbox
    as well!</p>
    <input type="email" name="email" required>
    <input type="hidden" name="_captcha" value="false">
    <input type="hidden" name="Advice" value="As a Researcher, you possess skills that are crucial
    when working on a research project. Be a guide to citizens by advising them with good practices
    about data collection and data analysis. Be flexible and keep in mind that your work colleagues
    might not possess the same skills and experience you have. You possess admirable qualities such
    as honesty, integrity, and a strong work ethic. Your sense of responsibility and loyalty make you a
    reliable contributor to any project. Your preference for clear guidelines and structured
    environments allows you to excel in managing tasks effectively. While you value established rules,
    try to be flexible in unstructured environments. Avoid being judgmental towards those who hold
    different viewpoints.">
    <a href="start.html"><button>Submit</button></a>
  </form>
  <br><br>
  <h3>By submitting your email you agree to receive a follow-up email with the same advice within
  a week. <br> I am offering this as a service for the time of my graduation project, so if you have any
  questions about the advice, citizen science or my project feel free to email me at
  <br><br><b>a.krivosik@student.utwente.nl</b></h3>
  <br><br><br><br>
  <div class="return">
```



```
<p>Ahh, I don't need an extra email, fill in feedback form instead!</p>
<a href="thankyoupage.html"><button>Finish and fill in feedback form!</button></a>
</div>
<br><br>
<script src="script.js"></script>
</body>
</html>
```

### Thank You Page

```
<!DOCTYPE html>
<html>
<head>
  <link rel="stylesheet" type="text/css" href="thankyouCSS.css">
  <meta name="viewport" content="width=device-width, initial-scale=1.0">
  <title>Thank you!</title>
</head>
<body>
  <h1>Thank you for taking the time to finish the exercise!</h1>
  <a href="https://forms.gle/YFVzkzH5aETN1kGs9">
    <button>Fill in feedback form!</button>
  </a>
  <h2>Short briefing</h2>
  <p>The research question of my graduation project is: <b>What are the most suitable methods to inform citizen scientists and stakeholders about their roles in citizen science projects in order to reduce the effects of citizen science washing?</b></p>
  <p>The term citizen science washing is derived from the well-known term greenwashing which is the "practice of promoting environmentally friendly programs to deflect attention from an organization's environmentally unfriendly or less savoury activities" (De Freitas Netto et al., 2020)</b></p>
  <p>In my case, after analyzing 500 projects and their funding processes, I define citizen science washing as the practice of intentionally or unattentively distributing funds based on ambiguously written project proposals, which might not have to do anything with citizen science. Since, in the past years citizen science has been in the headlines more grants and funding has been given to such projects. After my research on the 500 projects, I realized that only 38% of them were actually connected to citizen science. This number shook me and that is why I decided that I want to raise awareness about it.</p>

  <br><br>
  <h3>I would like to ask you to fill in the feedback please.</h3>
  <p>That would help me improve this tool and help more people as well!</p>

  <a href="https://forms.gle/YFVzkzH5aETN1kGs9">
    <button>Fill in feedback form!</button>
  </a>
```

```
<footer>De Freitas Netto, S. V., Sobral, M. F. F., Ribeiro, A. R. B., & Soares, G. R. D. L. (2020).
Concepts and forms of greenwashing: a systematic review. Environmental Sciences Europe, 32(1).
https://doi.org/10.1186/s12302-020-0300-3
```

```
</footer>
</body>

</html>
```

## **CSS**

```
html, body {
  height: 90%;
}
```

```
html {
  display: table;
  margin: auto;
}
```

```
body {
  font-family: Arial, sans-serif;
  background-color: #f2f2f2;
  margin: 0;
  padding: 20px;

  display: table-cell;
  vertical-align: middle;
}
```

```
h1 {
  text-align: center;
  color: #333;
}
```

```
.question-container {
  background-color: #fff;
  border-radius: 10px;
  padding: 20px;
  margin-bottom: 20px;
  box-shadow: 0 2px 6px rgba(0, 0, 0, 0.1);
}
```

```
h2 {
  font-size: 20px;
  color: #333;
  margin-bottom: 10px;
}
```

```
p {
  font-size: 16px;
```

```
    color: #666;
  }

.button-container {
  display: flex;
  justify-content: center;
  margin-top: 20px;
}

button {
  background-color: #4CAF50;
  color: #fff;
  border: none;
  border-radius: 4px;
  padding: 10px 20px;
  cursor: pointer;
  font-size: 16px;
  transition: background-color 0.3s ease;
  margin-left: 12px;
}

button:hover {
  background-color: #45a049;
}

@media (max-width: 768px) {
  body {
    padding: 10px;
  }

  .question-container {
    padding: 10px;
    text-align: center;
  }

  h2 {
    font-size: 18px;
  }

  p {
    font-size: 14px;
  }

  .button-container {
    flex-direction: row;
  }
}
```

```
    align-items: center;
  }

  button {
    font-size: 25px;
    padding: 8px 16px;
    margin-bottom: 10px;
    width: 100px;

    text-align: center;
  }
}
```

### **Advice CSS**

```
html, body {
  height: 95%;
  margin: 10px;
  padding: 15px;
}

body {
  display: flex;
  flex-direction: column;
  justify-content: center;
  align-items: center;
  font-family: Arial, sans-serif;
  background-color: #f2f2f2;
  margin: 0;
  padding: 20px;
}

.return {
  position: fixed;
  left: 0;
  bottom: 0;
  width: 100%;
  background-color: #f2f2f2;
  padding: 10px;
  text-align: center;
  margin-bottom: 20px;
}

form {
  display: flex;
  flex-direction: column;
```

```
align-items: center;
padding: 20px;
border: 1px solid #ccc;
border-radius: 10px;
background-color: #fff;
margin-top: 20px;
max-width: 700px;
width: 100%;
}
```

```
h1 {
  color: #333;
  text-align: center;
  font-weight: normal;
}
```

```
p {
  color: #666;
  line-height: 1.5;
  text-align: center;
  display: flex;
  flex-direction: column;
  justify-content: center;
  align-items: center;
}
```

```
label {
  font-weight: bold;
}
```

```
input[type="email"] {
  padding: 5px;
  border: 1px solid #ccc;
  border-radius: 10px;
  width: 100%;
  box-sizing: border-box;
  margin-bottom: 10px;
}
```

```
footer {
  background-color: #333;
  color: #fff;
  text-align: center;
  padding: 20px;
  position: fixed;
  bottom: 0;
  left: 0;
```

```
right: 0;
font-size: 9px;
}

button {
background-color: #4CAF50;
color: #fff;
border: none;
border-radius: 4px;
padding: 10px 20px;
cursor: pointer;
font-size: 16px;
transition: background-color 0.3s ease;
margin-top: 10px;
}

button:hover {
background-color: #45a049;
}

h3 {
text-align: center;
font-weight: normal;
}

@media (max-width: 768px) {

html, body {
height: 150%;
margin: 0px;
padding: 15px;
}

form {
max-width: 1000px;
}

.email_text {

padding: 10px;
text-align: center;
}

.return {

display: none;
position: fixed;
left: 0;
```

```

bottom: 0;
width: 100%;
background-color: #f2f2f2;
padding: 0px;
text-align: center;

}
}

```

## JavaScript

```
// Initialize an array to store the answers
```

```

var currentQuestion = window.location.pathname.split("/").pop();
var currentQuestionNumber = parseInt(currentQuestion.match(/\d+/)[0]);

```

```
function goToNextQuestion() {
```

```

    var nextQuestionNumber = currentQuestionNumber + 1;
    var nextQuestion = "question" + nextQuestionNumber + ".html";

```

```

    // Navigate to the next question
    window.location.href = nextQuestion;
}

```

```
// Define functions to handle the button clicks
```

```

function answerYes() {
    if (currentQuestionNumber == 1)
    {
        var researcher = [0,0,0,0,0,0,0,0];
        var leader = [0,0,0,0,0,0,0,0];
        var explorer = [0,0,0,0,0,0,0,0];
        var citizenScientist = [0,0,0,0,0,0,0,0];
        var activist = [0,0,0,0,0,0,0,0];

```

```

        sessionStorage.setItem("researcher", JSON.stringify(researcher[0] += 5));
        sessionStorage.researcher = JSON.stringify(researcher);

```

```

        sessionStorage.setItem("leader", JSON.stringify(leader[0] += 1));
        sessionStorage.leader = JSON.stringify(leader);

```

```

        sessionStorage.setItem("explorer", JSON.stringify(explorer[0] += 1));

```

```

sessionStorage.explorer = JSON.stringify(explorer);

sessionStorage.setItem("citizenScientist", JSON.stringify(citizenScientist[0] += 2));
sessionStorage.citizenScientist = JSON.stringify(citizenScientist);

sessionStorage.setItem("activist", JSON.stringify(activist[0] += 1));
sessionStorage.activist = JSON.stringify(activist);

goToNextQuestion();
//console.log(researcher)

}
if (currentQuestionNumber == 2)
{

researcher = JSON.parse(sessionStorage.researcher);
leader = JSON.parse(sessionStorage.leader);
explorer = JSON.parse(sessionStorage.explorer);
citizenScientist = JSON.parse(sessionStorage.citizenScientist);
activist = JSON.parse(sessionStorage.activist);

sessionStorage.setItem("researcher", JSON.stringify(researcher[1] += 2));
sessionStorage.researcher = JSON.stringify(researcher);

sessionStorage.setItem("leader", JSON.stringify(leader[1] += 1));
sessionStorage.leader = JSON.stringify(leader);

sessionStorage.setItem("explorer", JSON.stringify(explorer[1] += 5));
sessionStorage.explorer = JSON.stringify(explorer);

sessionStorage.setItem("citizenScientist", JSON.stringify(citizenScientist[1] += 3));
sessionStorage.citizenScientist = JSON.stringify(citizenScientist);

sessionStorage.setItem("activist", JSON.stringify(activist[1] += 5));
sessionStorage.activist = JSON.stringify(activist);

goToNextQuestion();
console.log(researcher)

}
if (currentQuestionNumber == 3)
{
researcher = JSON.parse(sessionStorage.researcher);
leader = JSON.parse(sessionStorage.leader);
explorer = JSON.parse(sessionStorage.explorer);
citizenScientist = JSON.parse(sessionStorage.citizenScientist);

```



```

activist = JSON.parse(sessionStorage.activist);

sessionStorage.setItem("researcher", JSON.stringify(researcher[2] += 0));
sessionStorage.researcher = JSON.stringify(researcher);

sessionStorage.setItem("leader", JSON.stringify(leader[2] += 5));
sessionStorage.leader = JSON.stringify(leader);

sessionStorage.setItem("explorer", JSON.stringify(explorer[2] += 2));
sessionStorage.explorer = JSON.stringify(explorer);

sessionStorage.setItem("citizenScientist", JSON.stringify(citizenScientist[2] += 3));
sessionStorage.citizenScientist = JSON.stringify(citizenScientist);

sessionStorage.setItem("activist", JSON.stringify(activist[2] += 1));
sessionStorage.activist = JSON.stringify(activist);

goToNextQuestion();

}
if (currentQuestionNumber == 4)
{
researcher = JSON.parse(sessionStorage.researcher);
leader = JSON.parse(sessionStorage.leader);
explorer = JSON.parse(sessionStorage.explorer);
citizenScientist = JSON.parse(sessionStorage.citizenScientist);
activist = JSON.parse(sessionStorage.activist);

sessionStorage.setItem("researcher", JSON.stringify(researcher[3] += 1));
sessionStorage.researcher = JSON.stringify(researcher);

sessionStorage.setItem("leader", JSON.stringify(leader[3] += 1));
sessionStorage.leader = JSON.stringify(leader);

sessionStorage.setItem("explorer", JSON.stringify(explorer[3] += 3));
sessionStorage.explorer = JSON.stringify(explorer);

sessionStorage.setItem("citizenScientist", JSON.stringify(citizenScientist[3] += 2));
sessionStorage.citizenScientist = JSON.stringify(citizenScientist);

sessionStorage.setItem("activist", JSON.stringify(activist[3] += 2));
sessionStorage.activist = JSON.stringify(activist);

goToNextQuestion();
}
if (currentQuestionNumber == 5)
{

```

```

researcher = JSON.parse(sessionStorage.researcher);
leader = JSON.parse(sessionStorage.leader);
explorer = JSON.parse(sessionStorage.explorer);
citizenScientist = JSON.parse(sessionStorage.citizenScientist);
activist = JSON.parse(sessionStorage.activist);

sessionStorage.setItem("researcher", JSON.stringify(researcher[4] += 0));
sessionStorage.researcher = JSON.stringify(researcher);

sessionStorage.setItem("leader", JSON.stringify(leader[4] += 5));
sessionStorage.leader = JSON.stringify(leader);

sessionStorage.setItem("explorer", JSON.stringify(explorer[4] += 0));
sessionStorage.explorer = JSON.stringify(explorer);

sessionStorage.setItem("citizenScientist", JSON.stringify(citizenScientist[4] += 2));
sessionStorage.citizenScientist = JSON.stringify(citizenScientist);

sessionStorage.setItem("activist", JSON.stringify(activist[4] += 5));
sessionStorage.activist = JSON.stringify(activist);

goToNextQuestion();
}
if (currentQuestionNumber == 6)
{
researcher = JSON.parse(sessionStorage.researcher);
leader = JSON.parse(sessionStorage.leader);
explorer = JSON.parse(sessionStorage.explorer);
citizenScientist = JSON.parse(sessionStorage.citizenScientist);
activist = JSON.parse(sessionStorage.activist);

sessionStorage.setItem("researcher", JSON.stringify(researcher[5] += 2));
sessionStorage.researcher = JSON.stringify(researcher);

sessionStorage.setItem("leader", JSON.stringify(leader[5] += 5));
sessionStorage.leader = JSON.stringify(leader);

sessionStorage.setItem("explorer", JSON.stringify(explorer[5] += 0));
sessionStorage.explorer = JSON.stringify(explorer);

sessionStorage.setItem("citizenScientist", JSON.stringify(citizenScientist[5] += 3));
sessionStorage.citizenScientist = JSON.stringify(citizenScientist);

sessionStorage.setItem("activist", JSON.stringify(activist[5] += 0));
sessionStorage.activist = JSON.stringify(activist);

goToNextQuestion();

```

```

}
if (currentQuestionNumber == 7)
{
    researcher = JSON.parse(sessionStorage.researcher);
    leader = JSON.parse(sessionStorage.leader);
    explorer = JSON.parse(sessionStorage.explorer);
    citizenScientist = JSON.parse(sessionStorage.citizenScientist);
    activist = JSON.parse(sessionStorage.activist);

    sessionStorage.setItem("researcher", JSON.stringify(researcher[6] += 2));
    sessionStorage.researcher = JSON.stringify(researcher);

    sessionStorage.setItem("leader", JSON.stringify(leader[6] += 0));
    sessionStorage.leader = JSON.stringify(leader);

    sessionStorage.setItem("explorer", JSON.stringify(explorer[6] += 3));
    sessionStorage.explorer = JSON.stringify(explorer);

    sessionStorage.setItem("citizenScientist", JSON.stringify(citizenScientist[6] += 3));
    sessionStorage.citizenScientist = JSON.stringify(citizenScientist);

    sessionStorage.setItem("activist", JSON.stringify(activist[6] += 2));
    sessionStorage.activist = JSON.stringify(activist);

    goToNextQuestion();
}
if (currentQuestionNumber == 8)
{
    researcher = JSON.parse(sessionStorage.researcher);
    leader = JSON.parse(sessionStorage.leader);
    explorer = JSON.parse(sessionStorage.explorer);
    citizenScientist = JSON.parse(sessionStorage.citizenScientist);
    activist = JSON.parse(sessionStorage.activist);

    sessionStorage.setItem("researcher", JSON.stringify(researcher[7] += 2));
    sessionStorage.researcher = JSON.stringify(researcher);

    sessionStorage.setItem("leader", JSON.stringify(leader[7] += 1));
    sessionStorage.leader = JSON.stringify(leader);

    sessionStorage.setItem("explorer", JSON.stringify(explorer[7] += 5));
    sessionStorage.explorer = JSON.stringify(explorer);

    sessionStorage.setItem("citizenScientist", JSON.stringify(citizenScientist[7] += 2));
    sessionStorage.citizenScientist = JSON.stringify(citizenScientist);

    sessionStorage.setItem("activist", JSON.stringify(activist[7] += 0));

```

```

    sessionStorage.activist = JSON.stringify(activist);

    analyzeAnswers();
}
}

function answerNo() {
    if (currentQuestionNumber == 1)
    {
        var researcher = [0,0,0,0,0,0,0,0];
        var leader = [0,0,0,0,0,0,0,0];
        var explorer = [0,0,0,0,0,0,0,0];
        var citizenScientist = [0,0,0,0,0,0,0,0];
        var activist = [0,0,0,0,0,0,0,0];

        sessionStorage.setItem("researcher", JSON.stringify(researcher[0] += 0));
        sessionStorage.researcher = JSON.stringify(researcher);

        sessionStorage.setItem("leader", JSON.stringify(leader[0] += 1));
        sessionStorage.leader = JSON.stringify(leader);

        sessionStorage.setItem("explorer", JSON.stringify(explorer[0] += 3));
        sessionStorage.explorer = JSON.stringify(explorer);

        sessionStorage.setItem("citizenScientist", JSON.stringify(citizenScientist[0] += 0));
        sessionStorage.citizenScientist = JSON.stringify(citizenScientist);

        sessionStorage.setItem("activist", JSON.stringify(activist[0] += 1));
        sessionStorage.activist = JSON.stringify(activist);

        goToNextQuestion();
    }
    if (currentQuestionNumber == 2)
    {
        researcher = JSON.parse(sessionStorage.researcher);
        leader = JSON.parse(sessionStorage.leader);
        explorer = JSON.parse(sessionStorage.explorer);
        citizenScientist = JSON.parse(sessionStorage.citizenScientist);
        activist = JSON.parse(sessionStorage.activist);

        sessionStorage.setItem("researcher", JSON.stringify(researcher[1] += 2));
        sessionStorage.researcher = JSON.stringify(researcher);

        sessionStorage.setItem("leader", JSON.stringify(leader[1] += 1));
        sessionStorage.leader = JSON.stringify(leader);
    }
}

```

```

sessionStorage.setItem("explorer", JSON.stringify(explorer[1] += 0));
sessionStorage.explorer = JSON.stringify(explorer);

sessionStorage.setItem("citizenScientist", JSON.stringify(citizenScientist[1] += 0));
sessionStorage.citizenScientist = JSON.stringify(citizenScientist);

sessionStorage.setItem("activist", JSON.stringify(activist[1] -= 1));
sessionStorage.activist = JSON.stringify(activist);

goToNextQuestion();
}
if (currentQuestionNumber == 3)
{
researcher = JSON.parse(sessionStorage.researcher);
leader = JSON.parse(sessionStorage.leader);
explorer = JSON.parse(sessionStorage.explorer);
citizenScientist = JSON.parse(sessionStorage.citizenScientist);
activist = JSON.parse(sessionStorage.activist);

sessionStorage.setItem("researcher", JSON.stringify(researcher[2] -= 3));
sessionStorage.researcher = JSON.stringify(researcher);

sessionStorage.setItem("leader", JSON.stringify(leader[2] += 0));
sessionStorage.leader = JSON.stringify(leader);

sessionStorage.setItem("explorer", JSON.stringify(explorer[2] += 0));
sessionStorage.explorer = JSON.stringify(explorer);

sessionStorage.setItem("citizenScientist", JSON.stringify(citizenScientist[2] += 0));
sessionStorage.citizenScientist = JSON.stringify(citizenScientist);

sessionStorage.setItem("activist", JSON.stringify(activist[2] += 1));
sessionStorage.activist = JSON.stringify(activist);

goToNextQuestion();
}
if (currentQuestionNumber == 4)
{
researcher = JSON.parse(sessionStorage.researcher);
leader = JSON.parse(sessionStorage.leader);
explorer = JSON.parse(sessionStorage.explorer);
citizenScientist = JSON.parse(sessionStorage.citizenScientist);
activist = JSON.parse(sessionStorage.activist);

sessionStorage.setItem("researcher", JSON.stringify(researcher[3] += 0));
sessionStorage.researcher = JSON.stringify(researcher);

```

```

sessionStorage.setItem("leader", JSON.stringify(leader[3] += 1));
sessionStorage.lead = JSON.stringify(leader);

sessionStorage.setItem("explorer", JSON.stringify(explorer[3] += 0));
sessionStorage.explorer = JSON.stringify(explorer);

sessionStorage.setItem("citizenScientist", JSON.stringify(citizenScientist[3] += 0));
sessionStorage.citizenScientist = JSON.stringify(citizenScientist);

sessionStorage.setItem("activist", JSON.stringify(activist[3] += 5));
sessionStorage.activist = JSON.stringify(activist);

goToNextQuestion();
}
if (currentQuestionNumber == 5)
{
researcher = JSON.parse(sessionStorage.researcher);
leader = JSON.parse(sessionStorage.lead);
explorer = JSON.parse(sessionStorage.explorer);
citizenScientist = JSON.parse(sessionStorage.citizenScientist);
activist = JSON.parse(sessionStorage.activist);

sessionStorage.setItem("researcher", JSON.stringify(researcher[4] -= 3));
sessionStorage.researcher = JSON.stringify(researcher);

sessionStorage.setItem("leader", JSON.stringify(leader[4] += 0));
sessionStorage.lead = JSON.stringify(leader);

sessionStorage.setItem("explorer", JSON.stringify(explorer[4] += 3));
sessionStorage.explorer = JSON.stringify(explorer);

sessionStorage.setItem("citizenScientist", JSON.stringify(citizenScientist[4] += 0));
sessionStorage.citizenScientist = JSON.stringify(citizenScientist);

sessionStorage.setItem("activist", JSON.stringify(activist[4] -= 1));
sessionStorage.activist = JSON.stringify(activist);

goToNextQuestion();
}
if (currentQuestionNumber == 6)
{
researcher = JSON.parse(sessionStorage.researcher);
leader = JSON.parse(sessionStorage.lead);
explorer = JSON.parse(sessionStorage.explorer);
citizenScientist = JSON.parse(sessionStorage.citizenScientist);
activist = JSON.parse(sessionStorage.activist);

```

```

sessionStorage.setItem("researcher", JSON.stringify(researcher[5] += 2));
sessionStorage.researcher = JSON.stringify(researcher);

sessionStorage.setItem("leader", JSON.stringify(leader[5] += 0));
sessionStorage.leader = JSON.stringify(leader);

sessionStorage.setItem("explorer", JSON.stringify(explorer[5] += 3));
sessionStorage.explorer = JSON.stringify(explorer);

sessionStorage.setItem("citizenScientist", JSON.stringify(citizenScientist[5] += 0));
sessionStorage.citizenScientist = JSON.stringify(citizenScientist);

sessionStorage.setItem("activist", JSON.stringify(activist[5] -= 3));
sessionStorage.activist = JSON.stringify(activist);

goToNextQuestion();
}
if (currentQuestionNumber == 7)
{
researcher = JSON.parse(sessionStorage.researcher);
leader = JSON.parse(sessionStorage.leader);
explorer = JSON.parse(sessionStorage.explorer);
citizenScientist = JSON.parse(sessionStorage.citizenScientist);
activist = JSON.parse(sessionStorage.activist);

sessionStorage.setItem("researcher", JSON.stringify(researcher[6] += 2));
sessionStorage.researcher = JSON.stringify(researcher);

sessionStorage.setItem("leader", JSON.stringify(leader[6] -= 3));
sessionStorage.leader = JSON.stringify(leader);

sessionStorage.setItem("explorer", JSON.stringify(explorer[6] += 0));
sessionStorage.explorer = JSON.stringify(explorer);

sessionStorage.setItem("citizenScientist", JSON.stringify(citizenScientist[6] += 0));
sessionStorage.citizenScientist = JSON.stringify(citizenScientist);

sessionStorage.setItem("activist", JSON.stringify(activist[6] += 1));
sessionStorage.activist = JSON.stringify(activist);

goToNextQuestion();

}
if (currentQuestionNumber == 8)
{
researcher = JSON.parse(sessionStorage.researcher);
leader = JSON.parse(sessionStorage.leader);

```

```

explorer = JSON.parse(sessionStorage.explorer);
citizenScientist = JSON.parse(sessionStorage.citizenScientist);
activist = JSON.parse(sessionStorage.activist);

sessionStorage.setItem("researcher", JSON.stringify(researcher[7] += 2));
sessionStorage.researcher = JSON.stringify(researcher);

sessionStorage.setItem("leader", JSON.stringify(leader[7] += 1));
sessionStorage.leader = JSON.stringify(leader);

sessionStorage.setItem("explorer", JSON.stringify(explorer[7] -= 3));
sessionStorage.explorer = JSON.stringify(explorer);

sessionStorage.setItem("citizenScientist", JSON.stringify(citizenScientist[7] += 0));
sessionStorage.citizenScientist = JSON.stringify(citizenScientist);

sessionStorage.setItem("activist", JSON.stringify(activist[7] += 1));
sessionStorage.activist = JSON.stringify(activist);

analyzeAnswers();
}
}

// Function to navigate to the next question

function analyzeAnswers() {

researcher = JSON.parse(sessionStorage.researcher)
sumResearcher = 0;
for (let i = 0; i < researcher.length; i++) {
sumResearcher += researcher[i];
}

leader = JSON.parse(sessionStorage.leader)
sumLeader = 0;
for (let i = 0; i < leader.length; i++) {
sumLeader += leader[i];
}

explorer = JSON.parse(sessionStorage.explorer)
sumExplorer = 0;
for (let i = 0; i < explorer.length; i++) {
sumExplorer += explorer[i];
}
}

```



```

citizenScientist = JSON.parse(sessionStorage.citizenScientist)
sumCitizenScientist = 0;
for (let i = 0; i < citizenScientist.length; i++) {
sumCitizenScientist += citizenScientist[i];
}

activist = JSON.parse(sessionStorage.activist)
sumActivist = 0;
for (let i = 0; i < activist.length; i++) {
sumActivist += activist[i];
}

if (sumResearcher >= sumActivist && sumResearcher >= sumExplorer && sumResearcher >=
sumLeader && sumResearcher >= sumCitizenScientist) {
window.location.href = "advice1.html";
}
if (sumLeader >= sumActivist && sumLeader >= sumResearcher && sumLeader >= sumExplorer
&& sumResearcher >= sumCitizenScientist) {
window.location.href = "advice2.html";
}
if (sumExplorer >= sumResearcher && sumExplorer >= sumLeader && sumExplorer >=
sumCitizenScientist && sumExplorer >= sumCitizenScientist) {
window.location.href = "advice3.html"
}
if (sumCitizenScientist >= sumResearcher && sumCitizenScientist >= sumLeader &&
sumCitizenScientist >= sumExplorer && sumCitizenScientist >= sumActivist) {
window.location.href = "advice4.html";
}
if (sumActivist >= sumResearcher && sumActivist >= sumLeader && sumActivist >= sumExplorer
&& sumActivist >= sumCitizenScientist) {
window.location.href = "advice5.html";
}

console.log(JSON.parse(sessionStorage.researcher));
console.log(sessionStorage.leader);
console.log(sessionStorage.explorer);
console.log(sessionStorage.citizenScientist);
console.log(sessionStorage.activist);

}

function goToStart() {

//currentQuestionNumber = 0;

```

```

    goToNextQuestion();
}

//mobile footer apperance logic
window.addEventListener('scroll', function() {
    var footer = document.querySelector('.return');
    var scrollTop = window.innerHeight + window.pageYOffset;
    if (scrollTop >= document.documentElement.scrollHeight-50) {
        footer.style.display = 'block';
    } else {
        footer.style.display = 'none';
    }
});

```

## PHP

```

<?php
ini_set("SMTP", "adoriankrivosik@gmail.com");
ini_set("smtp_port", "587");

error_reporting(E_ALL);
ini_set('display_errors', '1');
ini_set('log_errors', '1');
ini_set('error_log', 'error.log');

if ($_SERVER['REQUEST_METHOD'] === 'POST') {
    $email = $_POST['email'];
    $Advice = $_POST['Advice'];

    // Construct the email message
    $to = $email;
    $subject = "Your tailored advice";
    $message = "$Advice";
    $headers = "From: adoriankrivosik@gmail.com"; // Replace with your email address

    // Send the email
    $result = mail($to, $subject, $message, $headers);

    if ($result) {
        echo "Email sent successfully";
    } else {
        echo "Failed to send the email";
    }
}

$servername = "localhost";
$username = "root";
$password = "";
$dbname = "csdb";

```

```

// Create a new connection
$conn = new mysqli($servername, $username, $password, $dbname);

// Check the connection
if ($conn->connect_error) {
    die("Connection failed: " . $conn->connect_error);
}

// Get the email from the form submission
$email = $_POST['email'];
$Advice = $_POST['Advice'];

$message = mysqli_real_escape_string($conn, $Advice);

// Prepare and execute the SQL query to insert the email address
$sql = "INSERT INTO emails (email, advice) VALUES ('$email', '$message')";

if ($conn->query($sql) === TRUE) {
    echo "Email saved successfully";
} else {
    echo "Error: " . $sql . "<br>" . $conn->error;
}

// Close the database connection
$conn->close();

header('Location: https://admiring-fire-17114.pktriot.net/thankyoupage.html');
exit;
?>

```