

# Citizen Science Participation: A framing analysis

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## Summary

Citizen Science (CS) is when citizens are involved in conducting scientific research. CS projects have been applied to a diversity of topics using a diversity of methods. Historically, there are two strands of CS. One strand focuses on the potential that CS has to democratize science by making it more relevant, transparent, and inclusive. The other strand focuses on the ability for CS to gather more data, in locations that may have been inaccessible, and on longer time scales. Both strands require the recruitment and retention of volunteers to reach the proposed benefits, and the goals of the project.

Recruiting and retaining participants is a significant challenge for CS projects and can constitute a significant portion of the costs in running such projects. There is an ever growing amount of research being conducted on how CS participation can be increased. There are two dominant approaches research has taken thus far. Motivation-based research analyzes why individuals participate and based on this information determine how participation can be increased. Intervention-based research analyzes the effectiveness of project designs and strategies to increase participation.

There are issues with the current dominant research approaches that make evidence-based decision making difficult. This thesis explores how the framing and design of a project can influence participants. It is proposed that through influencing participants, project framing and design influence the results of research. This occurs participant framing influences their behaviour and communication. Since the framing of participants is influenced by the project framing and design, research results are a reflection of the project design and framing, rather than best practices. This can explain the contradictory and diverse findings of previous research. To explore this issue a systematic literature review of CS participation research was conducted followed by a case study of a CS project that monitors butterflies, moths and dragonflies.

Based on the results of the literature review and the case study, project framing and design is found to significantly influence participants. This can occur through two methods. Either the project framing and design act as a selection process or participants are influenced by the project framing and design as they participate. Research supporting both conclusions is supported by evidence from the literature review and the case study. The research concludes by suggesting directions for future research to better understand CS participation and the influences of participant framing.

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## Chapter 1 Introduction

### 1.1 Citizen Science

Definitions of citizen science (CS) are varied and contested however most agree that it is “the inclusion of members of the public in some aspect of scientific research” (Eitzel et al, 2017). Rather than being limited to merely being the subjects of research, CS participants are engaged to some degree in performing the research themselves. This differentiates CS from experiential learning (Hecker et al 2018) but has similarities with action research. CS fits within the broader concept of open science which supports increased participation in science by the general public and alternative models for producing knowledge (ibid.). Besides conducting research, CS projects can have societal, educational, or policy goals (ibid.) and a mix of goals is common (Grodzińska-Jurczak et al, 2018; Rambonnet et al, 2019).

Although the practice of CS can be traced back for more than a century (Curtis, 2018) the term ‘citizen science’ is more modern. The term originates from two separate strands of research with divergent purposes. Irwin (1995) used the term CS to describe citizens using scientific methods to address local environmental concerns that are relevant to them. This can be linked to participatory action research (Eitzel, 2017) and the larger movement of democratization of science. Conversely the term was also used by the Cornell Laboratory of Ornithology to describe professional scientists using non-scientist volunteers to assist research by collecting or evaluating data (Curtis, 2018). This strand views CS as an opportunity to collect data on a larger scale, in areas previously inaccessible or for a lower cost than previously possible.

As can be seen from the origins of the term CS, there was a strong link to environmental and biodiversity research. Traditionally, CS has involved participants gathering data in the field, however, CS has evolved to include a high diversity of topics. This includes: astronomy (Raddick, 2013), biology (Hobbs & White, 2012), ecology (Dem et al 2018), geography (Aucott, Southall & Ekinsmyth, 2019), environmental science (August et al 2017) meteorology (Eveleigh et al 2013) and more. CS can be conducted online, such as through the well-known platform Zooniverse, where participants classify images and audio, transcribe texts and perform other tasks from a computer.

Beyond the diversity in topics addressed, participants can be engaged in a variety of tasks. Bonney et al (2009) classified projects into three types: contributory, collaborative, and co-created. Contributory projects are designed and run by scientists, and citizen participants contribute data. Collaborative projects have participants contribute data but also provides the opportunity for participants to analyze data, disseminate findings or assist in the research design. Lastly, co-created projects allow for participants to be involved in all stages and aspects of the research project. It is also possible for co-created projects to be entirely run by citizens.

CS can benefit both the scientists and the participants. CS allows scientists to gather more data or data they ordinarily would not have been able to collect (Bonney et al 2009). For participants, CS can help direct research to make it more relevant and impactful for the participants (Hecker et al 2018) and has the potential for learning and empowerment (Edwards et al 2018).

Citizen science is operationalized based on the definition of Eitzel et al (2017) as: scientific research that includes and involves members of the public in performing research. This definition is inclusive and allows for diversity in CS projects for multiple reasons. First

CS is diverse, as some projects have educational goals, while others have scientific or activist goals (Grodzińska-Jurczak et al, 2018; Rambonnet et al, 2019). Second, and related to the first, even projects that may appear to not provide the earlier stated benefits of learning and empowerment (Edwards et al 2018) and increasing the relevancy and impact for participants (Hecker et al 2018), can have surprisingly profound impacts on participants. As an example, Kloetzer, Schneider and Da Costa (2016) found participants of a distributed computing CS project experienced significant benefits from participating including learning and socializing opportunities. Typically, distributed computing projects are viewed as passive, as the way individuals participate is by allowing a project to use their computer in the background for computing research data.

## 1.2 Research problem

There are two related research problems this thesis addresses; a broad problem, and a specific problem. The broad problem is the necessity and difficulties in recruiting and retaining participants for CS. This is addressed in 1.2.1. The specific problem is issues with prior research conducted to address the broad problem. This is addressed in 1.2.2.

### 1.2.1 Broad Research Problem

The broad research problem is the necessity and difficulties in recruiting and retaining participants. This section delineates this problem and discusses its relevance. Without the ability to recruit and retain participants, CS cannot achieve any of the suggested benefits or purposes. Although CS participants are most often volunteers, there are still costs associated with recruiting, training, and retaining volunteers (Jacobson, Carlton & Monroe, 2012). Consequently, one of the major challenges of CS is participant retention and recruitment (Conrad & Hilchey, 2011).

For the purpose of this thesis, increasing the retention and recruitment is viewed broadly and open ended. As the goals of CS projects are diverse, so too are the challenges for recruitment and retention. The goals of CS projects can include increasing public scientific literacy, gathering large and reliable data sets, gathering environmental data for conservation, encouraging and supporting activism and more (Follett & Strezoy 2015). Due to this diversity in goals and purposes of CS projects, the challenges and goals with participant recruitment and retention also differ.

There are three typical problems faced by CS projects: short term participants, challenges of recruiting participants, and a lack of diversity. Short term participants can participate as little as once to a project before dropping out. This can be problematic for various projects. Many online CS projects have a disproportionate contribution pattern where a minority of participants provide the majority of contributions (see for example Boakes et al. 2016; Rotman et al. 2014; Sauermann & Franzoni 2015). This means that most participants in these projects are only participating for short time periods. This can be problematic for projects which aim to increase scientific literacy as most participants will not participate for long enough to increase their literacy. Eveleigh et al (2014) argue that increased research efforts should be diverted to understanding short-term participants. Increasing their participation even a little will increase participation overall greatly, as short-term participants represent the majority of participants for many projects.

However, for a project with scientific goals, short-term contributions may not be problematic. For example, there have been several short-term CS projects where participants

can only participate for very short periods that were considered to be successful in achieving their goals (see Anonymous Authors, 2019; Reeves & Simperl, 2019). Additionally, not all CS projects struggle with participant retention (see for example Freitag & Pfeffer, 2013; Land-Zandstra et al, 2016b; Parrish et al, 2018). Research studying individuals who do not participate in CS demonstrate that the most significant barrier to participating is a lack of awareness (Crandall et al, 2018; Hermoso et al, 2019; Hobbs & White, 2012; Lucrezi et al, 2018). For these projects recruitment is a more relevant challenge.

A challenge relevant for certain CS projects is a lack of diversity. Pandya (2012) argues that historically underrepresented demographics in science are also underrepresented in CS. Hobbs & White (2012) found that lower income areas and participants were underrepresented in CS projects and this excludes them from social benefits associated with CS. This is problematic if the goal of the CS project is to democratize science as it can exacerbate social inequalities (Bela et al 2016). Pandya (2012) further argues that increased diversity in CS can increase the quality of research (Bang, Medin & Atran, 2007), and increase the learning outcomes of participants (Gurin, 1999).

Therefore, increasing participation is broadly operationalized in this thesis. It includes the three main challenges faced by projects: short term participants, recruitment, and diversity. These challenges are relevant because they need to be addressed in order to achieve the goals of projects and the potential benefits of CS.

### 1.2.2 Specific Research Problem

The specific research problem addressed by this thesis is the possibility that the framing and design of CS projects influences participants' framing. Frames are how we perceive and make sense of the world and how we communicate these perceived realities (Goffman, 1974). There are two important aspects to this:

1. Frames are how we communicate our perceived realities.
2. Second, frames are how we perceive and make sense of the world, and this influences the choices we make.

Why is this relevant for the broad problem of increasing participation defined in 1.2.1? To understand and increase participation knowledge is required. There is an ever-increasing amount of research performed on why individuals participate in CS and how participation can be increased (Wehn & Almomani 2019). However, if the framing and design of projects influence participants' framing, this can influence:

1. How participants communicate their perceived reality.
2. The choices participants make.

The first point would influence any research that relies on responses from participants, through surveys or interviews. The second point influences research that relies on measuring or observing participant behaviour and the choices they make. While alternative approaches to research CS participation exist, these two methods represent the majority of research conducted on CS participation (see chapter 2). The problems of each aspect for understanding and increasing CS participation are demonstrated through practical examples below.

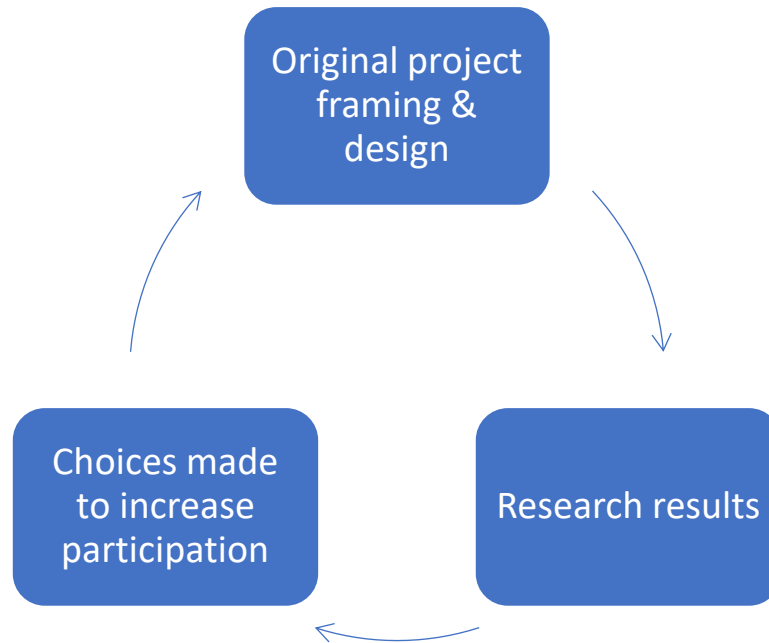
First, an example is provided demonstrating the problem of how participants communicate their perceived reality. CS project coordinators may want to know if encouraging social interaction could increase participation. Research on if social interaction motivates participants has mixed findings. Participants state that social interaction motivates them in some projects (Alender, 2016; Bell et al, 2008;; Holohan & Garg, 2017; Larson et al,

2020; Merenlender et al, 2016; Ng, Duncan & Koper, 2018; Phillips et al 2019; Reed et al, 2013) but not others (Land-Zandstra et al, 2016a; Land-Zandstra et al 2016b; Nov, Arazy & Anderson, 2011b). Coordinators therefor are not able to clearly determine if social interaction should be encouraged based on prior research. Research would have to be conducted on the project itself and its participants. This is where the problem arises. If the project framing and design influences the framing of the participant, then the results will reflect the framing and design used by the project. The results will depend on the project framing and design rather than what is ideal to increase participation.

Second, an example is provided demonstrating the problem of framing influencing the choices participants make. Gamification is a popular method used in CS to try to increase participation (Simperl et al, 2018). Gamification is when game elements, like points and badges, are applied to projects to increase participation. Research results are mixed with some research finding gamification can increase participation (see for example Aucott, Southall & Ekinsmyth, 2019) while other research finds it is not effective for increasing participation (see for example Prestopnik, Crowston & Wang, 2017). Once again, it is difficult to determine if gamification is an effective method for increasing participation based on prior research. Research would have to be conducted on the project itself, and the reactions of participants to gamification monitored. Once more this is where the issue arises. If project framing and design influences the framing of participants, and thereby the choices they make, these results reflect the project framing and design, rather than the efficacy of gamification.

In both cases, the project framing and design influence the results of research. Coordinators would make decisions based on this research. These choices would be influenced by the already existing framing and design used by the project. On the individual project level scale this means that choices made would only reinforce the current project framing and design. This would occur because the evidence used to make decisions is influenced by the framing and design of the project. Using the example previously provided, if gamification is positively framed and encouraged by the project design, research results would reflect that gamification is positive for participation. Coordinators would make decisions based on these results and further focus on gamification. This feedback loop is shown in *Figure 1*. Depending on the research approach, alternative framings and designs will either never be considered or research would find negative results.





*Figure 1 Feedback Loop caused by project framing and design*

If project framing and design creates the feedback loop of *Figure 1* is not problematic if a project is successful. The relevance of this feedback loop is for projects that struggle with the challenges of CS participation presented in 1.2.1: short term participants, challenges of recruiting participants, and a lack of diversity. Decision making that does not take the feedback loop into account will only reinforce or incrementally improve the current project framing and design. This project framing and design however is influencing participants, which may also include influencing short-term participation, difficulties in recruitment, or a lack of diversity. It is unlikely that these challenges will be met by solutions that only reinforce or incrementally improve upon the original framing and design of the project. Alternatives would have to be considered.

On a macro scale, the feedback loop means the general conclusions drawn from research would depend on dominant framings and designs used by projects. Future projects that base their decisions on prior projects and research would use similar project framings and designs. Hereby, the results of prior research would be further enforced, and alternatives would not be considered. The results of the research may or may not reflect best practices.

It is possible that no best practices exist for increasing participation. Rotman et al (2014) argue that due to the complexity of participation in CS, projects need to adjust the design of their project based on the “purpose, location, available infrastructure, participation practices, and the expectations of potential volunteers, with attention to cultural context and sensitivities and realistic use of technology” (p. 11). Considering the effects of project framing and design is still relevant. Research that does not consider the potential effect of the feedback loop may conclude that certain best practices do exist. In a systematic literature review on gamification in CS, Simperl et al (2018) conclude that gamification is not effective for recruiting participants but can increase long term participation. These results may reflect the current dominant framing and design of projects rather than best practices. Without considering the influence of project framing and design the validity of such conclusions remain uncertain.

Prior research has already mentioned the possibility of project framing and design influencing participants. Land-Zandstra et al (2016a) note the possibility that how organizers frame the project could influence participants. Phillips et al (2019) further argue that the specific context of projects can influence participants. Despite these observations, no research thus far has examined how and if the framing and design of projects can influence participants.

In summary the specific research problem is the possibility that the framing and design of CS projects influences participants' framing. By influencing participant framing, the results of research would also be influenced. Decision-making based on these results would reinforce the framing and design used by the project. This is not problematic for successful projects but is unlikely to solve the challenges presented in 1.2.1. Best practices determined by previous research may also reflect the framing and design of the projects researched rather than actual best practices. Prior research has suggested that project framing and design can influence participants, but no research to date has researched this.

### 1.3 Research Purpose

There are two purposes following from the two research problems: a broad purpose and a specific purpose. The broad purpose is to determine why individuals participate and how participation can be increased. The purpose of this is to address the challenges of recruiting and retaining participants to support in achieving the goals and benefits of CS.

The specific purpose follows from the specific problem. Based on current dominant research approaches (see chapter 2), it is not possible to determine how to best increase participation due to issues with internal validity. The issues of internal validity are caused by the possibility that the framing and design of a project influence participants as presented in 1.2.2. The specific purpose therefor is to determine the relationship between project framing and design and participant framing. It is possible that other factors influence participant framing, but these would be outside the control of CS project coordinators. These are therefor outside the scope of this thesis.

As a framing analysis has not been conducted before on this topic, the purpose of this research is to conduct exploratory research. The purpose of this exploratory research is to provide initial insights into the relationships between the project framing and design and participant framing. This will help contextual prior research and inform future research. The findings of prior research will be contextualized by considering if and how the influence of project framing and design influence the results. Future research will be informed by provided an initial analysis on the effects of project framing and design on participant framing. The purpose is to generate hypothesis to be tested in future research, and determine future research directions to better understand why individuals participate and how participation can be increased.

### 1.4 Research Questions

Following from the research problem and the research purpose the main research question that this thesis addresses is:

- *What is the relationship between the framing and design of a project and how participants frame their participation?*

Additionally, there are a series of sub-questions to further determine the relationship between the project framing and design and participants.

1. *What similarities and differences exist between the framing used by a CS project and the framing used by its participants?*
2. *How can the framing and design of a project act as a selection process?*
3. *How can the framing and design of a project influence how individuals frame their participation?*

To answer the main research question, the three sub questions require answering. First to determine if and to what extent project framing influences participant framing, it is necessary to determine how similar the two are. If the framing used by the project and its participants shares few similarities it is unlikely that the one influences the other. By analyzing how similar the framing used by the project is it will be possible to establish if and to what extent a relationship exists between the two. The second and third questions are to establish how the framing of participants is influenced. There are two possibilities. The second question addresses if the framing and design of a project act as a selection process. Participants with similar framings would choose to participate and continue to participate. Those with dissimilar framings would choose not to participate or choose to drop out. Hereby the project framing and design act as a selection process for participants with similar framings. The third question addresses if participants are influenced by the framing and design of the project as they participate. Participants may have a different framing before they participate, and as they participate their framing is influenced to being more similar to that of the project. By answering all three sub questions, it will be possible to answer the main question.

### 1.5 Scientific and Social Relevance

Determining the current state of knowledge on why individuals participate and how to increase participation is challenged by a number of factors. Based on a systematic review, Wehn and Almomani (2019) argued that most CS participation research does not ground their research in theories or concepts. Additionally, few studies related their findings back to the theory or framework used which obscures which theories or frameworks are useful. This lack of use and evaluation of theories and frameworks in the literature obscures which theories or frameworks could be useful to better understand and increase CS participation.

Currently a large diversity of methods and frameworks have been used to analyze why individuals participate. As an example of this diversity in frameworks, Nov et al (2011) classified motivations into the following 6 categories based on research by Klandermans (2004): collective, norm-oriented, identification, intrinsic, reputation, and social interaction. Rotman et al (2012) based their categorization on a model developed by Batson, Ahmad & Tsang (2002) with the following four categories: egoism, collectivism, altruism, and principalism. Eveleigh et al (2014) simply divide motivation into intrinsic and extrinsic based on the Work Preference Inventory developed by Amabile et al (1994). Other research does not categorize motivations (for example Land-Zandstra et al 2016a; Dem et al 2018). While some overlap does exist, there is a severe limitation to comparing results due to this diverse array of categorization and theories. Furthermore, since there is a lack of critically analyzing theories and frameworks as noted previously, it is uncertain which frameworks best explains why individuals participate.

However, what is shared by the majority of CS participation research is that it takes a positivist approach. The three main approaches taken by CS participation research discussed in Chapter 2 all are based on the assumption that reasons for participating and methods for increasing participation are independent of social contextual influence and can be objectively

measured. The relevance of this thesis to CS participation research is that it analyzes the base assumptions of the majority of CS participation research to determine if how participants frame their participation is influenced or related to the framing and design used by the project itself. This will help determine if the current positivist approach is suitable for analyzing why individuals participate in CS and how their participation can be increased.

A further challenge is the large diversity of project types and how individuals participate. There has been research on online CS projects (see for example Cox et al 2018), and offline (see for example Brooks et al 2019). Some researched projects have participants that collect data (see for example Land-Zandstra et al. 2016a), other projects have participants that analyze data (see Douthwaite et al 2019) and sometimes participants design and perform research of their own devising (see Kimura 2019). The tasks CS projects require participants to perform are sometimes simple (see Nov et al 2010), while others are complex and require several hours of training (see Freitag & Pfeffer, 2013). Projects are designed in different ways with some including gamification elements, while others focusing more on the importance of the task (see Tang & Prestopnik, 2019). Citizen science is used in the fields of astronomy (Raddick, 2013), biology (Hobbs & White, 2012), ecology (Dem et al 2018), geography (Aucott, Southall & Ekinsmyth, 2019), environmental science (August et al 2017) meteorology (Eveleigh et al 2013) and more. Given this diversity along with the diversity in methodology and frameworks it is difficult to determine what results are specific to that particular project and what results are more generalizable.

There are further complications and contradictions in determining why individuals participate and how to increase participation from the results of CS participation research. As an example some studies find that social interaction is positive (Alender, 2016; Bell et al, 2008;; Holohan & Garg, 2017; Larson et al, 2020; Merenlender et al, 2016; Ng, Duncan & Koper, 2018; Phillips et al 2019; Reed et al, 2013), while other studies find that it is not important (Land-Zandstra et al, 2016a; Land-Zandstra et al 2016b; Nov, Arazy & Anderson, 2011b) or even negative for increasing participation (Cox et al, 2018). Gamification, where game like elements are added to motivate participants, has also been found to be positive by some studies (Simperl et al 2018) while negative by others (Bowser, Hansen & Preece, 2013).

Although prior research has identified that project framing may impact why individuals participate (Land-Zandstra et al 2016a; Philips et al 2019) no research has been conducted thus far to further examine this relation. An exploratory analysis of the framing will provide additional insight into the effects of project framing and design has on its participants. This can offer an alternative explanation for why and how individuals participate and provide a method for characterizing the vast diversity present in CS.

The potential social relevance of CS is extensive. CS has been argued to contribute to transforming science to being more open, democratic, transparent and socially relevant (Conrad & Hilchey, 2011; Serrano Sanz et al 2014). The unprecedented scale of data collection CS is able to achieve has the potential to make significant contributions to issues such as biodiversity loss (Theobald et al 2015). Together with the potential to democratize science, this could also result in increased trust and acceptance of research findings and the scientific method.

More specific to this research, the main social relevance will be for CS project managers and coordinators. Since participant recruitment and retention are one of the major challenges of CS (Conrad & Hilchey, 2011), increased knowledge on how to achieve this is of great value. Although prior research has addressed CS participation, results and

suggestions are diverse and contradictory (see chapter 2). An analysis of how the design and framing of the project can influence how participants frame their participation will be able to provide insight for project coordinators for how their choices influence participants.

## 1.6 Reader Guide

This thesis consists of two major parts: a systematic literature review, and a case study. The literature review in Chapter 2 is used to provide argumentation to support the hypothesis that framing, and project design can influence participation. The literature review is performed systematically as this thesis challenges the underlying assumptions and validity of conclusions made by prior research. By performing a systematic review, the basis of the conclusions made is more transparent, and it can be assured that a significant and unbiased portion of the literature was included. Prior research is analyzed and compared to determine if and how framing and design can influence participants framing. This analysis is then used to demonstrate how prior results and conclusions were influenced by the framing and design of projects being researched. Chapter 2 concludes by providing the conceptual framework used to analyze framing and project design.

The rest of the thesis regards a case study to further explore the relationship between the framing and design of projects and participant framing. Chapter 3 provides details on the case selected for this thesis and the methodology used to analyze it. Chapter 4 presents the results of the framing analysis. Finally, chapter 5 discusses the results of analyzing what influence the framing and design of a CS project can have on how participants frame their participation. Conclusions are drawn, and suggestions are made for future research.

## Chapter 2 Literature Review

Based on an initial literature review it was determined that how a project is framed and designed could influence the results and conclusions drawn from research. A systematic literature review was then conducted to validate this hypothesis. A systematic literature review was performed due to the contentious and contradictory arguments put forth by this thesis. The argument of the thesis is that the results of prior research are not valid due to poor internal validity. This issue is caused by the influence project framing and design has on participants, and thereby on research results. A systematic literature review was selected to transparently and systematically demonstrate this argument.

The purpose of the systematic review is as follows. First to demonstrate that decision making for CS project coordinators is difficult based on prior research. Second that this difficulty is due to poor internal and external validity. Third that the poor validity of prior research is possibly due to the influence that project framing and design has on participants. Fourth, and last, to provide evidence that project framing and design influences research results by influencing the framing of participants.

The chapter concludes by presenting a conceptual framework that will be used to analyze the case study in the remained of the thesis. This conceptual framework outlines how project framing, project design, and participant framing were operationalized.

### 2.1 Systematic Literature Review Methods

Davis et al (2014) define a systematic review as a “process of systematically locating and collating all available information on an effect” (p. 1). Littell, Corcoran and Pillai (2008) further emphasizes that systematic reviews should be conducting in a transparent and

replicable manner. Some authors further define a systematic literature review as using quantitative meta-analysis methods (Snyder, 2019). However, this thesis uses the definition by Davis et al (2014) as within the field of CS research ‘systematic review’ has referred to the methodology for searching for articles. Methodologies used were not quantitative meta-analysis (see for example Wehn & Almomani, 2019; Simperl et al, 2018). What follows is a transparent description of the methodology used in this literature review.

### 2.1.1 Search Methodology

Articles were obtained in three ways. First a search was performed on the SCOPUS database using the search terms “citizen science” AND “motivat\*” OR “engagement”. Search terms were developed based on the recommendations by Snyder (2019) for developing search terms. Search terms were determined based on an initial review of the literature and then tested. Alternative search terms were tried, such as “participatory science”, based on terms identified by Kullenberg and Kasperowski (2016) in an analysis of CS, however no new or relevant articles were found. Second a manual search through all articles was conducted of the Citizen Science Theory and Practice Journal as this is the only dedicated journal for research on citizen science. The first two search methods were conducted on the 17<sup>th</sup> February 2020. Third a search was performed of articles cited in the articles and articles citing the most cited articles found using the other two methods was conducted until saturation was reached and no new articles were found. This process of back and forward snowballing follows the same methodology used by Gharesifard, Wehn and van der Zaag (2019) in their systematic review on community-based monitoring networks research. Based on prior knowledge of research on CS participation, it was observed that some articles were not listed in the SCOPUS database, thus suggesting there may be additional articles not included. Based on the 42 additional articles found using this method, using forward and backwards snowballing was effective and necessary for finding articles not listed in the SCOPUS database.

For all three methods a two-step selection process was used to determine if the article would be included. Snyder (2019) recommends that article titles and abstracts are first read to rule out any research that is clearly irrelevant. Then a subsequent full reading of the research allows for the final selection of research to be included. The primary selection criteria for including articles in this review was that the research was relevant in answering why individuals participate and how participation can be increased. Additionally, only research that collected primary data or used data from previous studies in novel ways was included. A few articles could not be assessed as access was not available. There were also a few articles with multiple versions, mostly conference papers that were later published in a journal. In these cases only the most recent version was included in the review. Conference papers were eligible for inclusion as they are often cited in the literature and one report (Geoghegan et al, 2016) was included as it was often cited.

### 2.1.2 Analysis of Research

For analyzing the research, a meta-narrative analysis was conducted. The meta-narrative analysis focused on the relationship between the project framing & design, participant framing and the results and conclusions made. A meta-narrative review is suitable for topics that have different conceptualizations and methodologies (Wong et al 2013). Rather than quantifying an effect, a meta-narrative analysis attempts to identify the research

traditions used on a topic and critically synthesize and analyze the findings using qualitative methods (ibid.). Snyder (2019), argues that this type of analysis can “synthesize the state of knowledge, and create an agenda for further research” (p. 335). This suits the purpose of this thesis.

To conduct the meta-narrative analysis a short summary for each article was written. This included the major results and information relevant for understanding the influence of project framing and design. Articles were grouped that included data on similar topics. The articles of these groups were then compared and contrasted to determine trends, contradictions and inconsistencies that demonstrate how project framing and design influence participants and thereby results.

To support the analysis information was collected on the theory or approach used in the research. Articles were coded a priori with the theory or approach used. To be coded with a theory it was required that the research used the theory to some degree in developing the methodology or analyzing the results. Theories that were only cited, but not used, were not included. The purpose of gathering this data is to demonstrate that the critique of prior research is relevant for the majority of research. This is required to support a critical assumption of this thesis. This assumption is that the dominant approaches used to analyze CS participation could be influenced by project framing and design. To support this assumption, it must be demonstrated that framing could influence the results, and that this is relevant for the majority of research conducted. Therefore, data is required to demonstrate what theories and approaches are used.

Attempts were made to further classify articles using typologies (for example Bonney et al 2009) and quantitative data. Due to issues in inconsistent and diverse methodologies and a lack of data, it was not possible to use this data to further the analysis. For example, following the typology of Bonney et al (2009), data was collected on the type of CS project research analyzed. Only 1.9% of studies were conducted on collaborative projects, and 3.8% on co-created projects, and the rest is conducted on contributory projects. The lack of data on collaborative and co-created projects does not allow for effective analysis. Determining if the type of project is relevant for the relationship between project framing and design and participant framing is therefore not possible using current research.

## 2.2 General Statistics

In total 156 articles were included in this literature review. 103 were obtained from the SCOPUS search, 11 from Citizen Science Practice and Theory, and 42 from citations. 121 were journal articles, 34 were conference papers and 1 was a report. Publication dates ranged from 2005 to 2020 and the full publication years can be seen in *Table 1*.

Year of Publication	Number of articles
2020	4
2019	40
2018	21
2017	22
2016	24
2015	10
2014	11
2013	11
2012	2
2011	4
2010	4
2009	1
2008	1
2005	1

*Table 1 CS participation research year of publication*

There are a wide range of theories and frameworks used in the research. The top 10 theories and frameworks used are shown in *Table 2*, an additional 31 theories or frameworks were used by one article each. As can be seen from *Table 2* the majority of studies use a motivation-based approach. Some of these studies further specify their approach using motivation theories such as self-determination theory (8 studies), volunteer functions index (Clary & Snyder, 1999) (3 studies), or social movement participation theory (Klandermans, 1997) (3 studies).

Theory	# of articles	% of articles
Motivation	109	70%
Gamification	20	13%
Self determination	8	5%
Theory of planned behaviour/reasoned action	6	4%
Grounded	5	3%
Volunteer functions index (Clary & Snyder)	3	2%
Social movement participation (Klandermans)	3	2%
Self-efficacy	3	2%
Social comparison	3	2%
Environmental values	2	1%

*Table 2 Most popular theories used in CS participation research*

There are two main approaches taken within CS participation research: motivation, and intervention. The strategy of motivation-based research is to determine the motivations of participants and based on this information attempt to increase participation. Intervention based research is defined as analyzing the effectiveness of interventions and strategies applied by CS projects to increase participation. Intervention based research drew from a variety of theories. The most often researched intervention was gamification. Although other approaches exist, such as theory of planned behaviour (see Martin & Greig, 2019, Martin et al, 2016b, Martin et al, 2016a; Wehn & Almomani, 2019), this represents a minority of research conducted on CS. The sample size of research using these other approaches and



theories are too small to allow for effective comparison and analysis. Therefore, only motivation and intervention research will be analyzed. What follows is a discussion on each approach, issues and gaps in knowledge, and evidence demonstrating project framing and design influence participant framing and thereby research results.

## 2.3 Motivation-Based Approach

Although motivation is an ill-defined concept in CS participation research, functionally it is most often implicitly defined as *the reasons why an individual performs an action*. Practically, determining the motivations of participants involves asking them for their motivations to participate through surveys or interviews. Based on this approach, it would appear clear why individuals participate in CS. Issues exist however, that show that understanding participant motivations is more complex. These issues are divided into 5 subsections below. The section concludes with a summary of the issues with motivation-based research and why a framing analysis is needed

### 2.3.1 Diversity of results

Motivations stated most often include: learning (Dem et al 2018; Richter, 2018; Rotman et al 2012; Domroese & Johnson 2017; He et al 2019), being involved in science (Dem et al 2018; Domroese & Johnson 2017), to support achieving the project's goal(s) (Richter 2018; Land-Zandstra et al 2016a; Raddick et al 2013; Curtis 2015; He et al 2019), and interest in topic (Land-Zandstra et al 2016a; Rotman et al 2012; Rotman et al 2014; Raddick et al 2013; Curtis 2015; Aucott et al 2019). However a high diversity of motivations have been reported including: participants wanting to know what their home water quality is (He et al, 2019), feeling a desire to observe nature (Dunkley, 2019), personal interest in the places (Aucott, Southall & Ekinsmyth, 2019), being able to participate when and how much they want (ibid.), protect the health of their families (Kimura, 2019), not trusting the results of previous research (Verbrugge et al, 2017), wanting their children to learn about the environment (Evans et al 2005), recreation (Wright et al, 2015), raising awareness for air quality issues (Van Brussel & Huyse, 2019) and many more. Although there are some similarities between projects, a large diversity still exists.

Given this diversity of motivation attempts have been made to classify motivations. This would allow for comparison between projects and between research. Nov et al (2011b) classified motivations into the following 6 categories based on research by Klandermans (1997): collective, norm-oriented, identification, intrinsic, reputation, and social interaction. Rotman et al (2012) based their categorization on a model developed by Batson, Ahmad & Tsang (2002) with the following four categories: egoism, collectivism, altruism, and principalism. Eveleigh et al (2014) simply divide motivation into intrinsic and extrinsic based on the Work Preference Inventory developed by Amabile et al (1994). Not following a specific theory, Raddick et al 2009 developed the following 12 categories of motivation based on forum posts and interviews: contribute, learning, discovery, community, teaching, beauty, fun, vastness, helping, zoo, astronomy, science. Other research does not categorize motivations (for example Land-Zandstra et al 2016a; Dem et al 2018), and other categorizations also exist for example based on the Volunteer Functions Index (Clary & Snyder, 1999).

While some overlap does exist, there is a severe limitation in comparing results due to this vast array of categories based on different theories with different methods of gathering

data. No clear standard classification method has been established in the research thereby limiting comparison of findings between studies. This limitation means that it is challenging to determine why differences or similarities exist in the motivations of participants between CS projects. While some research has studied multiple projects (see Philips et al 2019; Nov et al 2011b), these studies are often limited by small samples of projects.

What is clear from the research is that there is a large diversity of motivations. Project framing and design could explain these differences. Some of these differences would be obvious. For example, projects that have participants gather data in nature would find nature related motivations significant (see for example: Dunkley, 2019). Other motivations may be more nuanced. Darch (2017), found that seeing genuine images of galaxies was a significant motivator for participants. The project had framed itself as allowing participants to view genuine images of galaxies. Participants were not pleased when the project started showing simulated images as part of an experiment. Once the coordinators framed and designed the task including simulated images differently, participants were no longer negative about the simulated images. This demonstrates that the motivations of participants are influenced by the design of the project, and the framing of the project. Together this can explain the large diversity of motivations found in research.

### 2.3.2 Correlations to Participation

Beyond the challenges presented by the diversity frameworks and motivations found, broader issues and limitations could exist with a motivation approach. These issues demonstrate how there could be other underlying factors more influential than participant motivations. Based on survey responses, Golumbic, Fishbain and Baram-Tsabari (2019) found that those who did and did not participate reported being equally motivated. Frenslley (2017) also found no differences in motivation between those who continued to participate and those who quit. While other studies do find that retention and participation is positively correlated to motivation (see for example, Eveleigh et al 2014; Nov, Arazy & Anderson, 2014), it in the least demonstrates that other factors can be more influential for why individuals participate.

Research that correlates motivations to participation metrics often having surprising results. These results further suggest that motivation does not adequately describe why individuals participate. Based on an analysis of an online astronomy project, collective motivations were found to be the most prominent motivations based on survey data (Nov Arazy & Anderson, 2011a). However, the best predictors of continued participation were intrinsic and norm-oriented motivations (ibid.). Nov, Arazy and Anderson (2014) also determined that although collective motivations were scored highest on the survey, intrinsic motivation correlated best to participation quantity. However, collective motivations did correlate best with participation quality, which was operationalized as the correctness of contributions. In a comparative study between an image classification based project and a distributed computing project, Nov, Arazy and Anderson (2011b) found that collective motivations scored highest on a Likert scale survey for both projects. However collective motivations were not correlated to intentions to continue to participate for the distributed computing project and the second least correlated of six motivational categories for the image classification project. The best correlated motivation for both projects was intrinsic motivation. Cox et al (2018) found that being motivated by gaining new knowledge and expressing one's values was positively correlated to participation quantity and retention.

However, being motivated by social interaction or improving one's career was negatively correlated to participation quantity and retention. Eveleigh et al (2014) found that while both intrinsic and extrinsic motivations were correlated to participation quantity, only intrinsic motivations correlated to additional participation such as transcribing information from events and participating in the forum.

Therefore, understanding why individuals participate is not as simple as asking them, as certain motivations can negatively correlate to participation metrics. This demonstrates the limitations to using a motivation-based approach. It suggests that studies using a motivation-based approach need to ground their research in additional data or theories. The motivations stated by participants are perceived motivations and do not guarantee that participants are indeed motivated or will continue to participate. The negative correlations between motivations and participation could occur due to a mismatch between the project framing and design and the framing of participants. Participants who frame the project differently or have motivations not supported by the design of the project would choose to stop participating. This would result in participants being selected over time who have similar and compatible framings to that of the project.

### 2.3.3 The Influence of Methodology on Results

Further illustrating issues with a motivation-based approach are the several studies that have found different results when using different methods or questions on the same population. Ng, Duncan and Koper (2018) found that learning was the least often stated motivation for participating but the most often stated benefit of participating. Dem et al (2018) found participants of a CS project in the Philippines stated not being motivated for financial reasons, however their behaviour indicated that some were motivated for financial reasons. Aucott, Southall and Ekinsmyth (2019) similarly found differences in responses to the addition of a leaderboard. Survey data indicated the addition was not motivating, but interviews revealed that it did motivate some and demotivated others. Raddick et al (2013) found contribution was not the highest scored in the Likert scale questions but was ranked as most important by a large majority of participants. Johnson et al (2018) found that an open-ended survey question indicated social interaction as the least important motivation. However, almost half of interview participants mentioned it as important for their participation. Similarly, Merenlender et al (2016) found that career was least important based on survey results but was the second most cited motivation in interviews, although this may be due to a sample bias. There were no mentions of community in responses to an open ended survey questions in an study on Foldit, an online CS project (Curtis, 2015). However, 7/10 interviewees referred to the community as being a motivating factor, one referred to their team on Foldit as their folding family. Johnson et al (2014) found that based on a survey the most important motivations included: "opportunity to spend time in nature", and "opportunity to see wildlife" (p. 239). Through open ended questions, focus groups and interviews, these motivations were not reflected in the three categories that emerged: "to give back to society by participating in conservation activities", "a desire to learn", and "to alter education or career trajectories" (p. 239). Based on results from Sandhaus, Kaufman and Ramirez-Andreotta (2019) the framing of the question impacts the answer given. When participants were asked why they participate in a citizen science project most answered: concern for health, education/learning, evaluating the health of and growing food. However, when asked

why they participate in environmental action like the project they predominantly answered environmental preservation.

These results all suggest that the framing of the question impacts the results. It follows that the framing used by the project may influence how participants frame their participation and what motivates them. The optimal approach to measure motivations would likely be open questions or participant observation which minimize the influence of the questions. The results of these inquiries would still be perceived motivations, as the project is still likely influencing the results obtained. No methodology exists to determine the validity of measuring the motivations of participants. Even if it is possible to minimize question bias, it is difficult to prove that the stated motivations are genuine or just perceptions. What is being measured therefor is individuals' perception of what motivates them.

#### 2.3.4 Difficulties in using Motivation Research for Decision-Making

The validity of measuring motivations of participants is questionable, but if the results are able to increase participation, the validity of the motivations is less relevant. All models are wrong, but some are useful. This does not appear to be the case with motivation-based research, as there is little demonstration of its usefulness. Practical questions for CS projects are very difficult to answer with a motivation-based approach. For example, a CS project may want to know if encouraging social interaction between participants can increase participation and retention. Several studies found that although social factors were not the most significant motivation for participating, it was a significant motivation for a portion of participants (Alender, 2016; Bell et al, 2008; Holohan & Garg, 2017; Larson et al, 2020; Merenlender et al, 2016; Ng, Duncan & Koper, 2018; Phillips et al 2019; Reed et al, 2013). However, Nov, Arazy and Anderson (2011b) found that social interaction was considered the least important motivation by volunteers in two online astronomy projects. Land-Zandstra et al (2016a) similarly found that participants were not interested in socializing or interacting with other participants. Land-Zandstra et al (2016b) also found that social interaction was not a significant motivation in a project that helps track seasonal flus. So, while some studies find that social interaction is only somewhat important for participants, others find it is the least important motivation. This makes it difficult to determine if implementing changes to encourage social interaction would increase participation.

Further complicating matters, Ng, Duncan and Koper (2018) found that a reason for stopping was if their project partner stopped participating and Frensley (2017) found that drop out was influenced by lack of social interaction. This would suggest that social interaction is very important for participants. However, Ng, Duncan and Koper (2018) found that although most participants participated with a partner but those who participated alone participated for more years on average. Parrish et al (2018) similarly found that many participants collected data in pairs, however, this did not correlate to retention. These contradictory findings make decision making and determining best practices challenging. It is possible that no ideal method for increasing and maintaining participation exist. Rotman et al (2014) argue that due to the complexity of participation in CS, projects need to adjust the design of their project based on the "purpose, location, available infrastructure, participation practices, and the expectations of potential volunteers, with attention to cultural context and sensitivities and realistic use of technology" (p. 11). Phillips et al (2019) argue that the specific context of a projects influences participants' reasons for participation and He et al (2019) concluded that motivations are context and situation specific. However, analyzing

how project framing and design influences or is related to how participants frame their participation could provide answers to why social interaction seems important for participants in some projects but not others.

Despite these limitations presented, motivation has been shown to be useful in a very limited number of studies. When coordinators of Galaxy Zoo announced that they would be conducting an experiment using simulated images there was a strong backlash from some volunteers (Darch, 2017). Through studying participants' motivations, it was discerned that viewing genuine images of galaxies was an important motivating factor along with contributing to scientific research. Based on these results, the project coordinators were able to successfully adjust their communication with volunteers to match their motivations for participating. However, a framing approach could provide an explanation for these results as well. The backlash from the volunteers could have resulted because the experiment conducted was framed differently than how the project was previously framed. Participants were either influenced or selected to agree with this framing, and therefore disagreed with the experiment which did not include genuine images of galaxies. Domroese & Johnson (2017) used results from the first year of a longitudinal study on motivations of citizen scientists to adjust and advertise the project and found a 25% increase in the number of active participants. Without a control group the validity of these results is questionable, and comparison challenging.

Beyond research conducted by Darch (2017) and Domroese and Johnson (2017), discussions or data on how to apply the findings from motivation-based research is often neglected. Based on the results of the literature review, no clear methodology was delineated on turning knowledge of (stated) motivations to increased participation. The exception are a few motivation-based theories that have been used to research CS participation. A discussion of these theories and their use in CS participation research follows below.

### 2.3.5 Motivation-Based Theories

Beyond research conducted by Darch (2017) and Domroese and Johnson (2017), discussions or data on how to apply the findings from motivation-based research is often neglected. Most motivation-based research do not explicitly use theories to explain how a motivation-based approach could provide knowledge on increasing participation. However, a limited amount of research does use theories on how participation can be increased using results from motivation-based research. The three most prominent theories are: the Volunteer Functions Index (Clary & Snyder, 1999), Social Movement Participation (Klandermans, 2004), and Self determination (Ryan & Deci, 2000). These theories operationalize how participation can be increased using a motivation-based approach. What follows is a short description of each theory and how it is used in CS participation research. -

Clary & Snyder (1999) developed the Volunteer Functions Inventory (VFI) which categorizes motivations for volunteering into 6 functions: values, understanding, enhancement, career, social, and protective. Based on a functionalist sociological perspective, the decision to volunteer and continue to volunteer was hypothesized to depend on how well matched the messages and opportunities provided by the project are to the motivations of the individuals (ibid.).

While many CS studies cite Clary & Snyder (1999), few explicitly use the theory. Wright et al (2015) uses the VFI categories proposed by the theory and surveyed participants in a bird atlas project to determine their motivations and if their motivations were being

satisfied. It was found that level of motivation was correlated to if those motivations were satisfied. Cox et al (2018) also used the proposed categories of motivation and found there was a positive correlation between participation measures and the understanding and value motivations, but a negative correlation to social and career motivations. These results are not related back to the theory, however based on the data the zooniverse projects studied satisfy understanding and value motivations and do not satisfy career and social motivations. Ferster et al (2013) surveyed participants motivations using the VFI before and after participating in a 25-120 minute CS task. Although differences in motivations were found before and after participation the results were not related back to the theory. Nakayama et al (2019) did not explicitly use the theory however tried to assign a task based on motivation but found it did not result in a significant difference in participation quantity. But this may have been because they were not real participants in the project but rather recruited specifically for the experiment.

The VFI and its functionalist approach is perhaps most compatible and relevant for a framing analysis. However, no methodology is outlined by the theory or has been developed within CS research to analyze the messages and opportunities provided by CS projects. Yet, the VFI could provide a theory as to how a framing analysis could be used to increase participation. The framing of the project would have to match how the project is designed and how participants frame their participation. While some research has used the VFI, as shown, this theory is currently underutilized in CS participation research, and it is difficult to determine the efficacy of such an approach.

Klandermans (2004) draws on the economic concept of supply and demand to explain participation in social movements, where demand is the unrest or dissatisfaction in a society, and supply is the activism opportunities provided by organizers. Social movements happen when demand is linked to supply through mobilization.

Nov, Arazy and Anderson (2014), Nov Arazy and Anderson (2011a), and Nov, Arazy and Anderson (2011b) all only use categories of motivation proposed by Klandermans, none include the other aspects of this theory. Van Brussel and Huyse (2019) does not explicitly use Klandermans as a theoretical framework, however the results largely reflects the theory. Authors state that they perceive the success of their air quality CS project to be largely due to air quality being a timely issue and the project provided an outlet for that. Similar to the VFI, Klandermans' (2004) social movement participation theory is underutilized in CS research. This theory would suggest that participants choose to participate in projects that match how they perceive society. If they are dissatisfied about an issue, they may seek to participate in a CS project that addresses or researches this issue to satisfy their demand for social change. However, no research has been conducted within CS that fully uses this theory. A framing analysis could provide insight into how the framing used by a project is related to the framing used by participants. Klandermans' theory would suggest that the framing would act as a selection process, where participants choose to participate because the framing and design of the project addresses what participants perceive as problematic.

Self determination theory (SDT) divides motivation into intrinsic, where an action is performed because it is inherently interesting, and extrinsic, where an action is performed for a separable outcome (Ryan & Deci, 2000). Extrinsic motivation can be externalized, where motivation is controlled through rewards and punishments, or internalized where extrinsic motivation is integrated into the values and needs of the person. Intrinsic and internalized extrinsic motivation make individuals more motivated and increase their well-being. Social-

contextual events that increase feelings of competence, relatedness and autonomy support intrinsic motivation and the internalization of extrinsic motivation.

Tinati et al (2017) used SDT to analyze the findings but only by dividing motivation into intrinsic and extrinsic. Nov, Arazy and Anderson (2014) only applied SDT by including intrinsic motivation and found that while it positively correlated to participation quantity, it negatively correlated to participation quality. Cappa et al (2018) tested if extrinsic rewards, either money or online recognition, would increase participation and enjoyment levels. SDT would predict that externalizing motivation like this would decrease well-being and motivation. The results showed that both types of reward increased enjoyment and participation quantity. However, the participants of this study were specifically recruited for this study and did not participate in CS on their own.

Other studies include SDT to a greater degree. Jones et al (2018) compared citizen scientists to science hobbyists and found that the former showed greater signs of autonomy, competence and relatedness. Tiago et al (2017) similarly found that those who perceived greater autonomy, competence and relatedness participated more in a project that monitors biodiversity. Frensley (2017) analyzed interviews with CS participants and found that those who persisted in the project may have greater competence and that greater autonomy could increase participation. In a meta-analysis studies on Zooniverse projects, Dowthwaite et al (2019) found that autonomy is the most important factor for increasing engagement, followed by competence and relatedness was the least important.

A few studies have also attempted to apply SDT theory to increase participation in CS projects. Although changes were made to the Virginia Master Naturalist program based on SDT (Frensley, 2017), the outcome of these changes was not reported. Miller et al (2019) attempted to apply SDT hypothesis to Foldit and found that it was difficult to apply successfully. Different versions of the project were created with consideration for autonomy and competence. Applying these interventions with a control group of an unmodified version led to no changes or a slight decrease for re-completing levels.

Other studies, while not explicitly using SDT also tested different interface versions with different amounts of autonomy. Sprinks et al (2017) found that a user interface providing the greatest amount of autonomy did not lead to increased participation quantity, but individuals did prefer it. Sprinks et al (2019) also tested a full, ramped and stepped interface, where the full interface had the most autonomy. The ramped interface had the most contributions followed by the full and stepped the least. Those who had the full interface were twice as likely to return to contribute more. The stepped interface had the greatest number of markings per image however there was a trade-off with lowered contribution quality.

While less relevant for the framing of CS projects, SDT could be relevant for how project design influences how and why individuals participate. A framing analysis could provide insight as to why external motivations sometimes appear to increase participation such as found by Cappa et al (2018). In general, limited research has been conducted on applying SDT to increase CS participation, and research that has been conducted finds limited or mixed results. Further research will need to be conducted to determine if SDT is a useful approach for understanding why individuals participate, and how to increase participation.

The theories that outline how knowledge of participants' motivations can be used to increase participation are largely underutilized in CS participation research. The VFI and

Klandermans' theory are compatible with the framing approach used in this thesis. The VFI can provide insight into how participation can be increased. Klandermans' theory can explain how the framing of a project acts as a selection process for participants. SDT is not directly compatible or incompatible with a framing approach, but a framing analysis may be able to explain inconsistencies found.

### 2.3.6 Motivation Summary

In summary, there is a high diversity found in motivations between and within projects which makes comparison and applying findings to other contexts challenging. While there have been attempts to classify motivations, several methods have been developed with no standardization emerging, which results in comparison remaining challenging. Analyzing how the framing and design of the project influences or is related to how participants frame their participation could provide insight into the differences and similarities found in motivation-based research. Correlating motivations to participation metrics sometimes find that motivation does not explain the difference between those who continue to participate and those who drop out. Furthermore, certain motivations appear to negatively correlate to participation despite being commonly perceived to be motivating for participants. By conducting a framing analysis, possible explanations can be found that explain these confounding results. More fundamentally, the reliability and validity of measuring motivation is questionable as different methodologies applied to the same population return different results. This could be due to the framing of the questions used and demonstrates that it is possible that how the project is framed could influence how participants frame their participation. If project design and framing does indeed influence how participants frame their participation this would limit the findings of motivation-based research as it would be a demonstration of the project framing, rather than best practices for increasing and retaining participants. However, since no framing analysis has been conducted on CS, the effects of this are unknown. There are motivation-based theories, however these are mostly underutilized, yet could be relevant and compatible with a framing analysis. The next section discusses intervention-based research conducted on CS participation.

### 2.4 Intervention-Based Approach

For this thesis, intervention-based research is defined as research that analyzes the efficacy of interventions to increase participation in CS. This can include analyzing the effectiveness of recruitment campaigns (Andow et al, 2016; Brouwer & Hessels, 2019; Crall et al, 2017; Ferster et al, 2013), sending motivational messages to participants (Segal et al, 2015; Segal et al, 2018; van der Wal et al, 2016), and applying Social Comparison Theory (Diner et al 2018; Laut et al, 2017; Nakayama et al, 2019; Preist, Massung & Coyle, 2014).

The most researched intervention within CS is gamification. Gamification is when game like elements are used to increase participation. For example, participants can receive points for participation and compare themselves to others on leaderboards. Within CS research, gamification has diverse results. Some research finds gamification can increase participation, others find it is ineffective, and a large portion shows mixed results. In a systematic literature review on gamification in citizen science that included 29 studies, 14 found positive results, 14 found mixed results, and 1 found neutral results (Simperl et al 2018).



This section will demonstrate how project framing and design may influence the results obtained by this research. This can explain the mixed results obtained and the contradictions that exist within and between research. Since gamification is the most researched intervention in CS it will be used as an example. What follows is a discussion on why these differences may exist, and how a framing analysis may be relevant for better understanding the results from prior research. This will achieve the purpose of this literature review:

- to demonstrate that decision making for CS project coordinators is difficult based on prior research;
- that this difficulty is due to poor internal and external validity;
- that the poor validity of prior research is possibly due to the influence that project framing and design has on participants;
- to provide evidence that project framing and design influences research results by influencing the framing of participants.

Several studies report that participants have split opinions whether gamification motivates them and how they react to the addition of gamification elements. The differences in opinions can be explained due to differences in framing. Aucott, Southall and Ekinsmyth (2019) reported that a spike in involvement occurred when a leaderboard was introduced to the GB1900 project. Despite the increase in participation the opinions of the participants were mixed. Some participants found it motivated them while others felt demotivated as they could not realistically catch up to the leaders. Darch (2017) found similar results when a leaderboard was implemented in the Galaxy Zoo project. While some participants increased participation, others felt demotivated as they saw their small contribution as useless in comparison to those at the top of the leaderboard. Participants of Old Weather, a transcribing CS project, did not all perceive gamification elements positively (Eveleigh et al, 2013). Those who did see the gamification elements as confirmation of the value of their contributions. Darch and Carusi (2010) also found that participants who viewed gamification elements positively, viewed it as a way to confirm that their contribution was meaningful.

It appears that the difference between those who view gamification as positive and negative is how they frame and perceive the game elements. Those who positively frame gamification view it as confirmation that their contribution is valuable. The use of certain game elements such as leaderboards, may influence how participants perceive and frame their participation. These leaderboards make participants at the top seem more valuable and smaller contributions appear of less worth. Leaderboards would increase participation for those whose contribution seems valuable. Likewise, leaderboards would decrease participation for those whose contribution seems less valuable. This demonstrates that the project design and framing influence how individuals frame their participation and how they participate.

A study conducted on CS distributed computing projects further depicts differences of framings used by participants within the same project. Darch and Carusi (2010) classified participants into three categories: super crunchers, lay public, and alpha testers. Each group had a different opinion on the points system implemented in the projects. The super crunchers used the projects to benchmark their high-performance computers and were generally positive about the game elements. The lay public group, who participated for reasons more typically associated with citizen science, had a split opinion. Some stated they were

motivated by the scoring system, while others took offence to the suggestion, they were motivated by scoring points and competition. Those who took offence preferred to state they were motivated by contributing to science and society. However, they liked the score system as they saw it as a way to confirm their contribution. Finally, the alpha testers participated by helping project developers create and test the projects. These participants believed a good scoring system was important for their participation. The scoring system was important to them because they believed it was important for motivating other participants. Since they do not want to participate in a project they believe would be unsuccessful, they felt scoring systems were necessary. While all three categories of participants can view gamification positively, each does so differently. Differences in how they react to various interventions would likely be influenced by their particular framing of why they participate and the importance of gamification.

Certain results make this relationship more complex. There is sometimes a disconnect between how participants frame their participation and how they react to interventions such as gamification. A study on the Foldit project, found that gamification elements were not important according to a survey (Curtis, 2018). However, participants were unhappy when the points system was changed. This emotional response demonstrates that the gamification elements were important to them. Similarly, in a study on the EyeWire project, players did not report being significantly motivated by gamification elements (Tinati et al, 2017). Even so, coordinators observed that there was more participation in activities which offered higher points. There is possibly a disconnect between the perceived motivations of participants and their actions. Participants did not perceive gamification to be an important motivator, however gamification was effective in motivating participation. A framing analysis could illicit why this incongruity exists.

No research has conducted a framing analysis of CS projects. A study conducted by Ponti et al (2018) demonstrates how project framing influences how participants frame and react to interventions such as gamification. The study compared the Foldit project to the Galaxy Zoo project, over a one-year ethnographic study. Foldit is a game with a purpose, where gamification elements make up a significant portion of the project. Galaxy Zoo may make use of gamification elements but if implemented these are not a prominent feature of the project. Galaxy Zoo participants were negative about the idea of adding gamified elements. Foldit participants viewed gamification positively and were only concerned that gamified elements were added correctly. The participants of Galaxy Zoo expressed that adding gamified elements would ruin the fun of the project. The participants did not believe game elements should be added to the project. This contrasted the perspective of Foldit members. Gamification was viewed as part of the reason why participating in Foldit was enjoyable and fulfilling. Galaxy Zoo participants had concerns that adding gamified elements would harm the scientific validity and quality of work. Foldit members had similar concerns. They felt the scoring system sometimes encouraged activities with less scientific relevance. The Foldit members suggested that the scoring system should be adjusted to better encourage and reward activities of scientific relevance. No mentions were made of removing gamified elements completely. While Foldit members were mainly positive about gamified elements, there were instances where gamified elements had negative consequences. Gamification was argued to have led to decreased sharing between participants, resulting in decreased performance, and some members quit. Foldit members were not solely interested in the project because it was a fun game. Contributing to science was an important reason for their

participation similar to Galaxy Zoo participants. This study illustrates that the project framing influenced how the participants framed gamification. The difficulty is in determining if participants had prior positive or negative perceptions about gamification. The framing of the project could act as a selection process, or the framing of participants was influenced by participating in the projects.

It is difficult to determine if gamification can increase participation. A framing analysis is required to explain why gamification is sometimes effective, and at other times ineffective. The current research has contrasting findings, which makes it difficult to determine if and when gamification can increase participation. For example, Iacovides et al. (2013) and Simperl et al (2018) found gamification was not effective for attracting new participants but could assist in sustaining engagement over time. There is other research that finds the opposite of these two conclusions. Participants interviewed from a distributed computing project felt the team-based competition of the project was very important for their participation (Holohan & Garg, 2017). A few participants stated they joined because of the team-based competition. Further contradicting the conclusion of Iacovides et al (2013) and Simperl et al (2018), Bowser et al (2014) found that gamification could be important for attracting millennials. This demonstrates the contrast as research finds gamification is both effective and ineffective for attracting new participants. Similarly, there is research that finds that gamification is negative for participant retention. Bowser, Hansen & Preece (2013) found that gamification elements were considered distracting and negative by some long-term participants. Therefore the contradictions and uncertainty in findings exist on multiple levels. Researchers have concluded both that gamification is effective and ineffective for attracting new participants. Additionally, research has found that gamification can increase long term engagement but also that long term participants viewed gamification negatively. A more detailed analysis is required to determine why these differences exist.

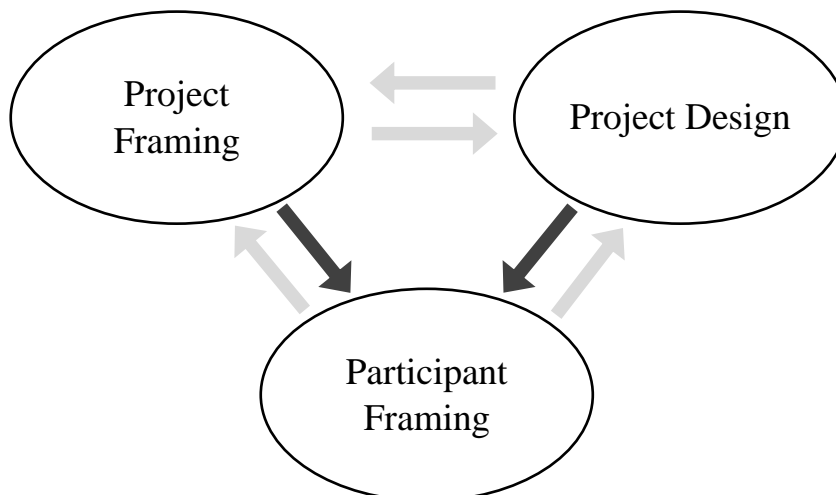
A possible explanation is provided by a series of studies conducted on the same CS project. Prestopnik & Tang (2015) conducted an experiment on participant experiences with a task framed version and a game framed version of the same citizen science project. Participants were recruited from computer science students, most of whom self-identified as gamers. The results showed that participants strongly preferred the game framed version. Prestopnik, Crowston and Wang (2017) repeated the study on a sample comprised of participants recruited from citizen science platforms. The results contrast those of the prior study. Participant retention was significantly higher for the task framed version of the project. Tang and Prestopnik (2019) also tested both versions for perceived enjoyment and perceived meaningfulness on a sample comprised of actual participants of the project. Both versions were enjoyable for participants but only the task framed version resulted in perceived meaningfulness for participants. Perceived meaningfulness was indirectly correlated to participation. Therefore, within the same project, the conclusions drawn depended more on who the participants were than what the independent variables were. This suggests that the framing participants have before participation can influence how they experience the project.

In conclusion, there is a diversity of findings on the effectiveness of gamification. Based on the results of prior research it is difficult to determine if gamification should be recommended for increasing participation. There are many contradictory findings, and differences of opinion exist between participants within the same project. Participants can frame gamification negatively despite project coordinators observing increased participation due to gamification. Framing offers a potential explanation and method for understanding

these results and determining the efficacy of gamification. The framing used by projects and participants appears to influence if research has positive or negative findings for gamification. This illustrates why a framing analysis is required to better understand CS participation and how it can be increased.

## 2.5 Conceptual Framework

This section outlines the conceptual framework used to analyse these three concepts: project framing, project design, and participant framing. Based on the results of the literature review, the design and framing of a project may influence how participants frame their participation. Following the research question of this thesis, the focus of the conceptual framework is on how the project framing and design can influence participants. Although it is possible that additional relationships exist between the three concepts this is outside the scope and purpose of this thesis. There are also likely other actors and influences for the project framing, project design, and participant framing. These are outside the scope and not relevant to this thesis. The concepts included in this thesis and the relevant relationships being analyzed is shown in *Figure 2*.



*Figure 2 Concepts and relationships analyzed*

To date, no research has conducted a framing analysis of CS participation. Therefore, a framework had to be developed to analyze framing drawing on research from other fields. Each concept analyzed will be operationalized and explained below.

### 2.5.1 Framing Framework

The following framework is used in this thesis to analyze how a project and participants frame participation. Methodologically, the concept of frames has been criticized as vague and the validity and reliability of framing analysis has been questioned (see Matthes & Kohring, 2008). Central to the critique are the issues with the qualitative and narrative based approaches. In these analyses the researcher develops a frame based on reading the source material. No specific framework is used. Any bias of the researcher may significantly influence the results. Due to the qualitative and narrative based approaches, it is difficult to separate or minimize the effect of bias. As such, attempts have been made to develop

frameworks that further delineate what a frame is, and further specify a methodology that can minimize researcher bias and increase the repeatability of framing analysis.

There are two main advantages to frameworks with explicit methodologies for analyzing frames. First, these frameworks will allow for a transparent method for comparing the framing. This is relevant for answering the research questions of this thesis as the frames will be easier to compare. Second, these framework will allow for comparison between research, as the methods are repeatable.

A combination of two frameworks have been used: Snow and Benford (1988) and Matthes and Kohring (2008). Snow and Benford (1988) divide framing into three categories: diagnostic, prognostic, and motivational. Diagnostic framing focusses on problems or issues that are identified and if any blame or causality is assigned. Prognostic framing focusses on the solutions that are proposed along with any accompanying tactics, strategies or targets. Motivational framing focusses on how actors are motivated to take action and can include “moral, status, solidary, and moral inducements” (p. 202).

The framework developed by Matthes and Kohring (2008) is based on Entman’s (1993) definition of framing:

*“to frame is to select some aspects of a perceived reality and make them more salient in a communicating context, in such a way as to promote a particular problem definition, causal interpretation, moral evaluation, and/or treatment recommendation for the item described” (p.52)*

Based on this definition, framing is divided into the following four elements: problem definition, causal interpretation, moral evaluation, and treatment recommendations. In the problem definition the topic being discussed, and the actors involved are coded. The causal interpretation codes which actors are responsible for causing the benefits or risks of the topic. The moral evaluation focusses on what consequences, either positive or negative, are assigned to the topic. Finally, in the treatment recommendations, codes are developed based on what recommendations or courses of action are suggested.

A summary of both frameworks and their overlap can be found in *Table 3*. In *Table 3*, it is shown that there is considerable overlap between both frameworks. However, a few relevant differences exist. The framework developed by Snow and Benford (1988) was developed to analyze the framing of social movements whereas Matthes and Kohring’s (2008) framework was developed to analyze media coverage of a particular topic. There is one main advantage of the framework developed by Matthes and Kohring (2008). The analysis of the problem discussed is more developed and includes a moral evaluation, the problem definition and determines causality. By including a moral evaluation of the topic, it is possible to code topics positively or negatively. Not all CS projects involve activism. Some projects, such as those involving astronomy, are focused on science rather than activism. For better analysis of such projects, it is useful to be able to allow for the possibility of positive framing.

	Matthes & Kohring's (2008) Framework	Snow & Benford's (1988) Framework
Framing of the topic, identifying actors involved and assigning responsibility	Problem definition	Diagnostic Framing
	Causal interpretation	
	Moral evaluation	N/A
Framing what is recommended and why individuals should take these actions	Treatment recommendations	Prognostic framing
	N/A	Motivational framing

Table 3 Overlap in framing frameworks used

The advantage of Snow and Benford's (1988) framework is that it includes a section on how potential participants are motivated to act and what tactics, strategies and targets are used. This is relevant for CS projects which are attempting to recruit and retain participants. This allows for codes about why individuals should participate. Additionally, it can allow for comparison with the stated motivations of the participants to join and remain in projects.

The combined framework, *Table 4*, shows each element and the questions that further specify each framing element. This was drawn from both frameworks and adapted to suit analyzing CS projects. Since not all CS projects may have 'problems' which they address, 'topics' was used instead. This also more clearly allows for positive and negative framing, as 'topic' does not imply a negative framing as 'problem' does.

Framing Element	Questions
Topic Definition	What is the topic? Who are the actors involved?
Causal Interpretation	Who is responsible for the risks of the topic? Who is responsible for the benefits of the topic?
Moral Evaluation	What are the benefits of the topic? What are the risks of the topic?
Prognosis	What are the suggested actions? What are the strategies, tactics, and targets?
Motivation	Why should someone participate in this project?

Table 4 Combined framing framework

It should be noted that both frameworks have elements that were not included. As this research is qualitative, the quantitative elements of the methodology of Matthes and Kohring (2008) were not used. Snow and Benford (1988) also hypothesize that social movements are most successful when there is alignment between each framing category. This is outside of the scope of this thesis since the focus is on the framing of projects and participants, rather than the success of a project.

### 2.5.2 Participation Framework

The participation framework is used in this thesis to provide structure to understanding participation in CS projects. It is used to obtain a narrative from participants so that their framing can be analyzed.

Prior research, as demonstrated in the literature review, often obtains contradictory findings. For example, research has found different results using different methodologies applied to the same sample (Aucott, Southall & Ekinsmyth, 2019; Curtis, 2015; Dem et al, 2018; Johnson et al, 2014; Johnson et al, 2018; Merenlender et al, 2016; Raddick et al, 2013; Ng, Duncan & Koper, 2018; Sandhaus, Kaufman & Ramirez-Andreotta, 2019). Therefor, rather than attempt to obtain an objective reality, the focus of the framework is to determine how participants perceive their participation. This follows research traditions such as the Theory of Planned Behaviour (Ajzen, 1991), and Self-Efficacy Theory (Bandura, 1978), which recognize that responses obtained from participants are perceptions rather than objective realities. As an example, an individual's perceived behavioural control, or self-efficacy, represents their perceptions of their capabilities, and this may not be reflective of their actual capabilities.

Therefor, for this thesis it is recognized that how participants frame their participation are subjective realities. Since the purpose of the research is determining the influence of project framing and design on how participants frame their participation, an objective reality is less relevant. The participation framework is only used to obtain the frame from participants. The frame will then be analyzed using the Framing Framework presented previously.

Following the qualitative and exploratory nature of this thesis research, the focus is on obtaining a narrative from participants. This narrative will then be used to analyze how participants frame their participation. A narrative approach to analyze participation acknowledges that participation is not a static experience (Crowston & Fagnot, 2008). Rather, how participants perceive their participation is dynamic and may change and shift throughout their experiences. The advantage of using a narrative approach is that it is more able to capture this entire experience. Thereby, a more complete frame is obtained for analysis and the influence of project framing and design may be more apparent.

It would not be suitable to determine how participants frame their participation using the framing framework. A separate framework is required because the absence of framing elements being present in a participant's framing is relevant and valid data. For example, participants may not mention actors responsible for the risks of the topic unless prompted. In this case, the fact that participants do not assign blame to specific actors is an aspect of their framing. If the same framework was used to illicit the frame and analyze the frame, it is more likely that participants will be influenced. The purpose of the framework therefor is to determine how participants frame their participation while minimizing influencing their responses.

To obtain a narrative from participants about their participation a framework was developed based on two frameworks from related fields: Crowston & Fagnot (2008) and Penner (2002). Crowston & Fagnot (2008) developed a framework for analyzing participation in massive virtual collaboration projects such as Wikipedia. The framework divides participation into three phases of contribution: initial, sustained, and meta. Initial participation is when the participant makes their first contribution to the project. Sustained participation is when a participant continues to participate. Finally, meta participation is when the participant makes contributions that go beyond the typical contribution. The model has several propositions for what influences participation in each phase drawing from other theories. Penner's (2002) framework for analyzing volunteering similarly divides volunteering into separate phases: decision to volunteer, initial volunteering, and sustained

volunteering. These phases of volunteering are hypothesized to be influenced by the dispositional characteristics of the individual, variables related to the organization, social pressure and situational factors.

The framework used is shown in *Table 5*. It includes the three stages of participation from Penner (2002). The stages from Penner (2002) were used because the last stage of participation, sustained, allows for an increased diversity in how participants participate. Additionally, Penner's framework (ibid) includes the decision to participate, which is relevant for obtaining a more complete narrative of an individual's participation in a project. Each stage has a main question further describing the stage. When all three stages are combined a narrative of participation is achieved. The Participant column of *Table 5* operationalizes each stage of participation using questions. The factors that influence participation from both Crowston & Fagnot (2008) and Penner (2002) are used to help clarify how participants frame their participation. These factors are not assumed to necessarily influence participation.

Participation Stage	Main Question	
	Participant	Project
<b>Decision to Participate</b>	Why did the participant decide to participate?	How are participants recruited?
<b>Initial Participation</b>	How do participants experience their initial participation?	How does the project interact with new participants?
<b>Continued Participation</b>	Why does the participant continue to participate?	How does the project interact with long term participants?

*Table 5 Participation framework*

### 2.5.3 Project Design Framework

Project Design is operationalized as any interaction that occurs between the project and its participants. For understanding project design, the Participation Framework is also used (*Table 5*). The three stages of participation are used to obtain information on how the project interacts with participants. This will provide qualitative data to determine how project design is related to the framing used by participants. The operationalization of each stage is shown in the Project column. Project designed is more easily directly observed and validated. Therefore, the same framework is used to analyze project design.

Alternative approaches to understanding project design have focused on classifying projects using typologies (for example Nov, Arazy & Anderson, 2014) and analysis of specific features (for example Rambonnet et al, 2019). The narrative based approach is used instead for two reasons. First, the focus is on the interaction between the design of the project and its participants. The most widespread typology in CS was developed by Bonney et al (2009) and includes three types: contributory, collaborative, and co-created. These types define what aspects of research participants are involved in. Classifying projects using typologies has been critiqued to not fully capture project design that is relevant for participants (Phillips et al 2019). These typologies may explain the structure of the project from a management perspective but are unable to explain the variety present in how individuals participate. The focus of these typologies is on the structure of CS projects, rather than interaction between the project and participants. Second, a narrative approach is more able to capture the diversity present in CS projects, than an analysis of specific features. As



demonstrated in the literature review, there is a large diversity in CS projects and participants. Analyzing what design features a CS project has is likely to be limited by an incomplete list of features due to the diversity of projects in CS. Additionally, some features may only be applied or relevant for some participants. A narrative approach will allow for a diversity in features and participants to emerge.

## **Chapter 3 Methods**

The following chapter outlines the methodological choices made for this thesis. Section 1 discusses the research philosophy that guided this research, and why this approach was chosen. Section 2 provides background information on the CS project analyzed in this thesis. Section 3 describes the data collection and data analysis methodology used to answer the research question. Finally, section 4 discusses the scope and limitations of this research.

### **3.1 Research Philosophy and Strategy**

This research follows an interpretivist research philosophy. An interpretivist philosophy views reality as socially constructed, dynamic and diverse (Saunders, Lewis & Thornhill, 2009). Based on the results of the literature review an interpretivist research philosophy, more specifically a social constructionist approach, was chosen for this research. This was selected based on the results of the literature review which revealed that the reasons why individuals participate appears to be diverse, dynamic, and influenced by how the questions are asked. The stated motivations also sometimes appear contradictory to how participants behave and react to facets of CS projects. This suggests that reasons to participate, or motivations, cannot or are difficult to objectively measure.

Typically, CS participation research has taken a positivist approach, as motivation has been assumed to be directly measurable. In contrast, a social constructionist approach examines how meaning is socially constructed rather than attempt to understand the cognitive processes and reality that influence decision making (Andrews, 2012). As such a social constructionist approach does not make ontological claims of what reality is, but instead focusses on the social processes by which meaning is constructed.

Following this perspective, there can be multiple realities, that which is subjective and socially constructed, and that which is objective and observable. An examination of why individuals participate in CS following this perspective does not focus on what the real reasons are that individuals participate but instead analyzes how the reasons stated are socially constructed. In the case of this research, the focus is on how the framing and design of the project influences or is related to how participants frame their participation. This is suited to a social constructionist approach because the focus is on how meaning is created.

A case study approach was selected for this thesis for 3 interrelated reasons. First, case studies examine a phenomenon in the real world, and includes consideration of contextual information. This approach contrasts an experimental approach, which minimizes outside influences, to isolate variables and relationships. Consideration of contextual information and researching the phenomenon of framing in the real world is important for this research. Prior research has found conflicting results using experimental approaches that does not research participation in situ (see section 2.4). Furthermore, the purpose and the research questions of this thesis are about determining the effect of contextual information (project framing and design) on participant framing. The second reason is that case studies are suited to exploratory research (Saunders, Lewis & Thornhill, 2009). Since it is uncertain

which specific factors if any influence participant framing, it is important to perform an explorative case study that considers a wide range of contextual information. The third reason is that case studies are suited to challenging assumptions from prior research, testing theories, and determining future research questions (ibid.). These are all relevant to the research purpose of this thesis.

### 3.2 Case

The Dutch Butterfly Conservation (DBC) is an organization that aims to increase the amount of butterflies and moths and includes a CS program to monitor the distribution and wellbeing of butterflies. Following the framework developed by Bonney et al (2009), the CS project is a contributory project. The CS project was started in 1990 in collaboration with Statistics Netherlands (Centraal Bureau voor de Statistiek) the Dutch governmental institution for collecting statistics for supporting policy development and decision making.

There are three different programs, one for butterflies, one for moths, and one for dragonflies. The program for butterflies is the oldest and has the most participants. For the butterfly program, participants, walk predefined routes and count the sightings of butterflies in their specified area. For some routes participants count all butterflies, whereas others count specific species that are of interest. Participants must complete the route once per week from April to September, however participants can choose the specific days and times they count provided certain weather conditions are met. The dragonfly project is the second oldest and was started in 1998. The dragonfly program functions similarly to the butterfly program, however project coordinators feel dragonflies are harder to count as there are more species and they move quicker. The most recent is the moth program which was started in 2012. Participating in the moth project used to require staying up during the night, however recent advancements in measurement techniques makes participating significantly easier. Participants now place a trap with a special light that attracts moths and collect the trap in the morning to count and release the moths. A recent initiative has also collaborated with farmers to also include farmland in their assessments as previously data was mostly collected in parks and backyards.

The DBC CS program was selected for this research as it is an established project that has been operating for a long time. This allows for researching participants that have been participating for varying time periods. There is also a large population of participants to draw from, and ample material is available for analyzing the framing and design of the project.

### 3.3 Research design

This section outlines the methodological choices made along with argumentation as to their suitability for this thesis. The research for this thesis can be divided into three sections: participant interviews, project coordinator interviews, and project framing analysis. The participant interviews were conducted to determine how participants framed their participation in the project. The project coordinator interviews were used to gain more information about how the DBC project is designed, and how coordinators interact with participants. The framing analysis was used to analyze the framing of the project. What follows is a detailed description of the methodological choices made for each section.

### 3.3.1 Project Framing Analysis

The framing of the project was analyzed using the Framing Framework outlined in chapter 2. The framework used can be seen in *Table 4*. Each framing element has a series of questions which were used to code the texts. A posteriori coding was used to allow the codes to emerge based on the texts themselves. Matthes and Kohring (2008) note that it is important to assess the reliability and validity of the codes used and to ensure that researcher bias is minimized. However, based on the literature review from chapter 2, no frame analysis has been conducted on CS projects, although it is possible that research not included in the review has done so. As such, since no prior codebook existed, a posteriori coding was used. Notes were made in a word processor following the framework outlined in chapter 2. These notes were used to create the narratives of how the project is framed.

For the project framing analysis the website of the project was used. As the CS project is only one aspect of what the DBC does, only those pages relevant to the CS project were included. The researcher attempted to mimic how a prospective participant would browse the website to result in a sample of the framing used by the DBC similar to what participants may view. The main webpage used was <https://www.vlinderstichting.nl/wat-wij-doen/meetnetten> and other pages directly clickable from that page.

### 3.3.2 Participant Interviews

Semi-structured interviews were conducted with participants. The structure for the interviews was based on the Participation Frameworks from chapter 2. Three stages of participation were included: decision to participate, initial participation, and sustained participation. Open questions were asked about each stage of volunteering along with more specific questions based on the hypothesis developed by Crowston and Fagnot (2008) and Penner (2002). Questions were as posed as open as possible to minimize influencing participants. Additionally, an introductory question was used to broadly ask about the individual's participation in the DBC project. The interview guide used can be seen in *Appendix A*.

Notes were made of the interview along with recordings when possible. The audio recordings or notes were coded using the Framing Framework outlined in chapter 2. The framework divides framing into 5 elements: topic definition, causal interpretation, moral evaluation, prognosis, and motivation. Each element has associated questions further detailing that element as can be seen in *Table 4*.

Participants from the DBC were selected with help from the project coordinators in order to include a diversity of participants in terms of how long they have been participating and in which program they participate. A total of 7 interviews were conducted, four interviews were conducted during the annual participants meeting of the DBC, while the other three were conducted online or via telephone. There were representatives from each of the three programs of the DBC CS project, and participation lengths that varied from being new participants to having participated since the project began (30 years). 6 interviewees were male and one was female. No data was collected on the ages of participants but the general age range was middle aged to retired.

### 3.3.3 Project Coordinator Interviews

Semi-structured interviews were conducted with staff members from the DBC. The structure for the interviews was based on the Participation Frameworks from chapter 2. This

framework divides participation into three stages: decision to participate, initial participation, and sustained participation. The same framework was used to analyze the interviews. Following the conceptual framework, a postiori coding was used to obtain a narrative of the design of the project and how DBC staff interact with participants.

All six staff members who engage with participants in the monitoring program were interviewed. There were two staff members who managed the social media accounts of the DBC and interacted with participants through social media. These staff members were also most involved in recruiting participants. Three staff members were the coordinators for the CS projects and regularly interacted with participants. They often were the point of contact within the organization for participants. Finally, one staff member was responsible for analyzing the data collected by participants and communicating this with them. Relevant staff members were determined using snowball sampling by asking interviewees if there were other staff members who engaged with participants of the monitoring program. All interviews were conducted at the DBC office.

### 3.4 Scope

The scope of this research is limited due to the exploratory nature of the research. Determining how the framing of a project influences participants is outside of the scope of this research. Rather the research focuses on qualitatively exploring the relationship(s) between project framing and design and participant framing. As previously stated, the reasons participants state for participating are analyzed only used to determine how participants frame their participation. Determining the actual reasons or motivations for participating in CS are outside the scope of this research.

## Chapter 4: Results

### 4.1 Project Framing

This section outlines the results of the framing analysis conducted on the website of the DBC. The following results were obtained from the framing analysis conducted on the website of the DBC. The format follows the framework developed in the conceptual framework outlined in Chapter 2. All quotes are translated from Dutch to English.

#### 4.1.1 Topic definition

##### *What is the topic?*

The topics identified are butterflies and collecting data about butterflies. The primary problem that is identified is that there is a decline in butterfly populations: “in the past you saw far more butterflies”. It is further emphasized that there are fewer species of butterflies present and those that are still present are endangered: “since the beginning of the twentieth century seventeen types of butterflies have disappeared from the Netherlands”. Development and nitrogen pollution are identified as part of the problem causing a decline in butterflies.

##### *What actors are involved*

The actors mentioned on the website as involved in the topic are: the DBC, Statistics Netherlands (CBS), BIJ12, European Invertebrate Survey NL (EIS), government (from local to international), land owners, businesses, and the volunteers of the CS project. The three most prominently mentioned actors are the DBC, their volunteers, and Statistics Netherlands (CBS).

#### 4.1.2 Causal Interpretation

##### *Who are responsible for the risks?*

There are no explicit mentions of actors who are responsible for the risks. It is implied that human development and land management are responsible for causing the decline of butterflies. However, these actors are only very vaguely implicated. For example: “what happens to the butterfly population if the grass is mowed” which only implies that those who would mow the grass may cause negative effects for butterflies. Furthermore “many suitable places [for butterflies] have had to make way for houses, roads, industry and agriculture” implies human development in general is responsible without accusing specific actors. Pollution is also identified as a potential risk for butterflies however the responsible party is once more unmentioned “what effect does nitrogen [pollution] have on butterflies”.

##### *Who are responsible for the benefits?*

The only two actors who are directly stated as being involved in a positive way is the DBC itself and the volunteers. The DBC “has already achieved different successes”. Volunteers are framed as: “the most important participants to the project are of course the many volunteers... without them the monitoring project would not exist”. While other actors are mentioned as being involved, they are not directly framed positively or responsible for benefits.

#### 4.1.3 Moral Evaluation

##### *What are the benefits of the topic?*

Butterflies are framed as a symbol of nature, joy and beauty; “butterflies are *the* symbol of beauty and joyfulness”. It is expressed that areas with lots of butterflies are a sign that nature is healthy in that location. Solving the issue of butterfly decline is framed as allowing future generations to enjoy the beauty of butterflies even more than we do.

##### *What are the risks of the topic?*

The risks of the problem are simply framed as that butterflies could disappear, especially rare types of butterflies. No further mentions are made of what risks the problem presents.

#### 4.1.4 Prognosis

##### *What are the suggested actions? What strategies, tactics and targets are identified?*

The solution to the problem is presented as monitoring butterflies, especially in a consistent and scientific manner. The gathered data is depicted as allowing the DBC to provide advice to policy makers and government to protect butterflies. Further mentions are made of working together with land owners, and businesses to protect butterflies. Finally, education and awareness raising are broadly raised as solutions to the problem. The only mention of a target for the CS project is the “gathering of information about changes in the butterfly population in the Netherlands”. A broader goal for DBC as a whole is to have butterflies everywhere where they should be.

#### 4.1.5 Motivational Messages

##### *Why should someone participate in this project?*

The framing of why someone should participate mostly focusses on having an interest in butterflies and their protection. Someone should participate to protect butterflies because

they like butterflies and have some prior knowledge. In a call to action the website states: “do you have reasonable knowledge of the butterflies or dragonflies in your area...?” and “would you enjoy walking a route [to count butterflies]?”. There are mentions of ensuring that future generations will be able to enjoy just as much as us; “we want that in a hundred years our great grandchildren can enjoy the beauty of butterflies”. There is a group or social element included in that it is enjoyable to count butterflies with others in a group. Finally, participation is presented as a way to protect butterflies so that “causes and changes can quickly be reversed” by the DBC.

## 4.2 Participants Framing

This section depicts how participants of the DBC monitoring programs frame their participation. The results were obtained from the interviews conducted with participants. The section follows the same framework used in the previous section outlined in the Conceptual Framework in chapter 2. All quotes were translated from Dutch to English.

### 4.2.1 Topic definition

#### *What is the topic?*

All participants mentioned that the problem was that butterflies/moths are not doing well with one participant framing it as a more general decline in biodiversity. For example, one participant mentioned “it is going poorly with butterflies” (participant 3). One participant further specified this issue as that there are fewer nectar plants for butterflies, two participants mentioned NO<sub>x</sub> as a problem, and three identified land development as a problem. One participant mentioned that there were not enough participants in the moth monitoring project of the DBC which was communicated to them by DBC staff.

#### *What actors are involved*

All participants referred to the DBC, and five made mentions of fellow volunteers for example how participants “sometimes cover [routes] for each other, we try to arrange, if someone is going on vacation, that someone will cover for the other” (participant 5). The following actors were mentioned by one participant each: municipalities, provincial government, Naturalis, IVN, landowners, and forest managers. As an example, one participant mentioned “I followed a couple of courses at the IVN” (participant 1) before participating with the DBC.

### 4.2.2 Causal Interpretation

#### *Who are responsible for the risks?*

Only one participant explicitly stated who was responsible for the risks or negative consequences of the problem. Although landowners were identified as responsible, the participant stated that they work together with them to protect butterflies. Two participants mentioned NO<sub>x</sub> as responsible without identifying parties responsible for that pollution.

#### *Who are responsible for the benefits?*

There are not any clear mentions of who is responsible for the benefits. Most participants implied themselves, fellow volunteers and the DBC as being beneficial, however this was never explicit. As an example participants mentioned their participation as their contribution to protecting butterflies or that monitoring butterflies was important for protecting butterflies. There are mentions that the DBC is a well-run organization, but it is not explicitly tied to benefits. One participant did however express that the DBC should be

more involved in assisting its volunteers in discussions with landowners to convince them to use land practices which are better for butterflies.

#### 4.2.3 Moral Evaluation

*What are the benefits of the topic?*

Only one participant made an explicit statement about benefits of the topic which was an increase in biodiversity. Other participants mentioned liking butterflies, and nature, but no explicit mentions were made of what the benefits were of the topic.

*What are the risks of the topic?*

The only risks associated with the problem is expressed as there being less butterflies. No participants further extrapolate what risks or consequences this could entail. Participants mentioned that butterflies were not doing well, but did not make statements as to why this was bad or important.

#### 4.2.4 Prognosis

*What are the suggested actions? What are the strategies, tactics, and targets?*

All participants mention that monitoring butterflies/moths is the solution to the problem, one participant stated “gathering data is very important” (participant 5). Four participants further specify that the monitoring has to be done consistently over a long-time scale to be effective. Two participants mentions working together with landowners to adjust land practices to be better for butterflies.

#### 4.2.5 Motivational Messages

*Why did the participant start participating?*

While the individual circumstances to how each participants joined are different a number of elements are shared in common. An interest in nature or butterflies, and believing conservation and monitoring is important was shared by all participants. Further similarities exist in having prior experience or hobbies relevant to the DBC monitoring programs. Two of the participants had already been birders for some time, and decided to also start monitoring butterflies. Another participant was a member of a local nature group, one had followed a course about butterflies and dragonflies, and one stated the importance of already being a member of the DBC. Some differences do exist however, as two participants did not feel they had much prior experience or knowledge about butterflies. Each participant’s individual reasons are expanded upon below.

Participant 1 decided to join after walking their dog one day and seeing lots of butterflies “I noticed a lot of butterflies flying... and that is how the ball started rolling. I contacted the DBC and eventually established those routes”. They had always been interested in nature and butterflies, followed courses about butterflies and dragonflies, and had already been a birder for some time.

Participant 2 had joined a local nature group because of their interest in nature, especially caterpillars. Someone from that group asked them to join the butterfly monitoring project and because they were interested in caterpillars and they had time available since their children were grown up, they joined. “I had an interest in caterpillars, and butterflies come from caterpillars”. The participant also felt that the project was fun “I just thought the project was fun”.

Participant 3 decided to join because they had always been interested in nature and felt this was a worthwhile and fun project to join. “from the beginning I thought it was very useful...it seemed a fun project which is also useful”

Participant 4 is a biologist and decided to join because they thought the project would be interesting and they could learn more and improve their skills. The participant enjoys being outside, and believes conservation is important, especially gathering data about nature for conservation. They would like to see what effects changes in the environment have on butterflies over time.

Participant 5 loves nature and wanted to do something practical for nature. They were already a member of the DBC and believed gathering data is important; “gathering data is important, it is the basis for everything”. They did not have much prior knowledge of butterflies, but did know a little, and so decided to join “I also did not have much knowledge about butterflies ... I did of course know a little... and you have to start somewhere”. In trying to recruit new participants they experience that requiring prior knowledge is a barrier and would like to see the organization have a beginner course or something for those who would like to count but do not have prior knowledge

Participant 6 had recently retired and was looking for something new to do to continue to challenge themselves mentally. They had prior experience with bird counting and believed it was important to do the same for other species so decided to join.

Participant 7 went to an event where a staff member from the DBC asked them to join. The DBC required someone to take over an important route. The participant had always liked nature but did not have prior experience or specific knowledge of butterflies. Previously they had chosen not to volunteer for any organizations because it required participation at rigid times, which did not suit them. Since the DBC projects allow for flexibility in when you perform the task they decided to join.

*Why did the participant continue to participate?*

Common themes in why participants continued to participate are that it is enjoyable, important to monitor butterflies, and because it is their contribution to conserving butterflies. What was stressed by three of the participants is the importance of gathering data over long time periods and this was a reason for their continued participation. While differences exist between participants, these differences are not contradictory, and often merely represent a different emphasis. Each participants' reasons are discussed in more length below.

Participant 1 continues to participate because they get lots of energy from being outside and enjoy participating. Even though they get exciting when they see a rare species or something unusual, they also enjoy seeing common species and just being outside. They believe that contributing to monitoring butterflies is important but mainly they continue to participate because they just enjoy doing it. A few times a year they go on a group excursion with a small group of other participants which they enjoy doing.

Participant 2 continues to participate because as the seasons change they get to see new butterflies and they look forward to when that species will be active again and they can see it. They like that the research is being performed at a national scale and so can compare their results to those of other areas. They believe it is important to monitor on a long time scale and see this as their contribution to protecting butterflies. The participant feels they learn lots and have fun doing the task, “you learn a lot from [participating]... what do butterflies need, why do they appear here but not there”.



Participant 3 continues to participate to help butterflies, and views long term monitoring as necessary to achieve this “that it is very useful, to follow the situation over a long time period”. The participant also simply stated they continue to participate because it is fun. They have also started to have a sense of ownership for their route “it becomes your own area”.

It was the first year participating for participant 4 and they stated that their reasons for continuing to participate are the same reasons they joined.

Participant 5 continues to participate because they keep learning more, and believe it is important to gather consistent data “you keep learning more, and it is important”. They expressed that their route is not that interesting but believe it is important to do anyways because of the data it provides and view their participation as their responsibility and contribution to protecting butterflies. The participant also mentioned that having the support from other volunteers in their area was important for their continued participation.

Participant 6 continues to participate because they enjoy participating and believe conservation is important.

Participant 7 continues to participate because they enjoy seeing the changes in nature between the seasons. They enjoy walking in nature and combine the butterfly monitoring with photography which is also their hobby. Finally, they like receiving the reports each year and seeing that their contribution is being used for the conservation of butterflies.

#### 4.3 Project Design

The following results were obtained from the interviews conducted with the six DBC staff members. These staff members were all involved in the monitoring programs and interact in some capacity with participants. The format follows the three stages of participation outlined in the conceptual framework presented in Chapter 2.

##### 4.3.1 Recruitment

Recruitment of new participants occurs through a variety of social media and email newsletters. The coordinators believe it is a big step to go from a follower of one of the DBC’s social media accounts to a participant in the monitoring, so they try to make the steps as small as possible. The Instagram and Facebook posts tend to have calls to action that are small and simple and there is not often a direct call for participants. Rather followers are encouraged to sign up for a newsletter which contains more information about the monitoring program. Coordinators focus on recruiting and engaging with potential participants who have similar interests such as nature or photography. For example, coordinators post on the Facebook page of *Nature Today* ([naturetoday.com](http://naturetoday.com)), a page for those interested in nature, twice a week. For current participants, coordinators ask them to take on additional routes, or start counting additional species when the need arises. This happens, for example, during the yearly meetings.

##### 4.3.2 Initial participation

Upon signing up on the website to become a participant in the monitoring program, a coordinator from the DBC makes an appointment to visit the participant. As the program has been growing, increasingly this initial meeting is handled by volunteers that have formed local groups. In this meeting, the coordinator determines what interests the participant and how knowledgeable they are without trying to come across as if they are being tested or

judged. Based on the responses the coordinator will attempt to match a monitoring location and task to their abilities and interests and will provide learning materials if required. Coordinators specifically attempt to choose monitoring locations that are close and easily accessible for volunteers. The coordinators also emphasize during this meeting how valued the contributions of the participants are both for the DBC and butterflies, moths and dragonflies.

#### 4.3.3 Continued Participation

There are two main events held each year which participants are invited to with a personal message from the DBC coordinators. The longest running is the annual meeting, where there are videos, lectures, discussions and information about all topics relevant to butterflies, moths and dragonflies, the work the DBC performs, and the current status of butterflies, moths and dragonflies. There is also an award for the land manager of the year. The meeting typically sees around 600 attendees. A newer addition is a meeting specifically for participants of the monitoring program where the focus is on how the data collected by participants is used, and the results obtained from the data. During these meetings, participants are sometimes asked to take on additional tasks or routes by the coordinators. For example, to also start counting dragonflies on their route. Beyond these meetings, coordinators try to regularly encourage and show appreciation to their volunteers by sending emails and messages on social media. There is a regular newsletter and once a year, participants are sent a document containing the results obtained from all the data collected by volunteers. When necessary, DBC staff assist participants in resolving land access or management issues with landowners. The coordinators try to serve as a point of contact for participants and meet as many participants as possible. Thereby if participants encounter issues, they can send a message to a coordinator from the DBC they have met, rather than sending a message to a general email address. A coordinator personally meets with local groups and organizations participating in the monitoring program and gives lectures about butterflies, conservation and the work done by the volunteers and the DBC. Participants in these groups tend to receive less personal contact from DBC staff members as a participant in the group tends to act as the contact person.

## Chapter 5 Discussion

This section discusses the results of the case study in relation to the research questions of the thesis. First the three sub-questions are discussed and then the main research question is discussed. The results are compared to prior research to support and compare the conclusions made. The section finishes with hypothesis for future research and a discussion on potential directions for future research.

### 5.1 What similarities and differences exist between the framing used by a citizen science project and its participants?

There is considerable overlap in the framing used by the DBC and its participants. This can not only be seen from what is stated but also what is left out. While there are differences between the framing used by the two parties, these differences are usually minor and the main focus used is mostly the same. Diversity exists in the participants and sometimes the framing of participants is contradictory to the framing used by the DBC. During the annual meeting of the DBC a participant approached a coordinator to explain that

the real cause of butterfly decline was chemtrails and suggested the coordinator research it. The coordinator politely disagreed. However, this was largely an exception, and most participants at the annual meeting seemed to agree with the DBC. For the seven participants that were interviewed, only minor differences existed in their framing, although this may have been due to a sampling bias. What follows is a detailed discussion on the five elements of a frame: problem definition, causal interpretation, moral evaluation, prognosis, and motivation.

#### 5.1.1 Topic definition

The framing used by the DBC and its CS participants is very similar. Both have a primary focus on the decline of butterflies. Less prominently included by the DBC is nitrogen pollution and land development and this was also included less often by participants. In terms of the actors involved there are more differences between the project framing and the participants' framing although considerable overlap still exists. Both the project and the participants made volunteers and the DBC have prominent roles in relation to the problem. Missing from the framing used by participants is the CBS and other organizations that gather and present the data to government. In conversation with one of the project coordinators from DBC they mentioned that they believed many participants were not aware of how the data was used to influence policy.

#### 5.1.2 Causal interpretation

Missing from both frames are clear attribution of risks to the problem. During an informal conversation during the annual participants meeting of the DBC a participant expressed that DBC participants are not activists like participants are in other projects. The participant preferred to identify themselves as a 'counter' (which the DBC uses to refer to its participants who help count butterflies) instead of an activist. This may be because practicing science and gathering data is seen as incompatible with activism. Alternatively, this could be explained by the role participants have in the organization, where their responsibility is gathering data, and the actions involved in turning data into policy changes happen behind the scenes.

The view that activism and science are incompatible is addressed by Kimura (2019). In an ethnographic study on citizens monitoring radiation levels in food to ensure safety, participants framed science as being irreconcilable with activism. Participants wanted to be seen as separate from anti-nuclear activism as they feared their results would not be taken seriously due to bias. By not associating with activism, participants felt their data would be taken seriously. DBC participants likely also view activism as separate from science and the work they do. The strong focus on science and data collection is likely seen as incompatible, and also not relevant for participants as their work focuses on gathering data rather than applying it.

#### 5.1.3 Moral evaluation

Both the framing used by the DBC and its participants lack extrapolating the consequences of biodiversity decline and the benefits of conservation. The DBC frames the benefits of conserving butterflies as allowing future generations to enjoy them. What is not present for both stakeholders that is present in similar topics, such as bee conservation, is a discussion on what consequences a decline in butterflies would have.

More important than why this occurs, is that alternative framings exist. The British Butterfly Conservation lists 7 categories of reasons why butterflies are important to conserve (Butterfly Conservation, n.d.).

#### 5.1.4 Prognosis

The framing used by the DBC and its participants to depict what should be done about the issue are very similar. Both parties focus on monitoring, especially over a long time period, as the solution. The DBC further frames this as allowing them to influence and inform policy, however participants do not mention this.

This is similar to the study conducted by Ponti et al (2018). The strategies used by the project were considered the best way to conduct a CS project. The project that used and positively framed gamification also had participants that positively framed gamification. The project that did not use gamification and negatively framed gamification also had participants that negatively framed gamification. Participants of the DBC positively frame long term data collection. It is likely that they would negatively perceive campaigns that do not focus on long term data collection. An example of these projects are projects where large amounts of participants gather data in a short time period by a large amount of participants (see Anonymous Authors, 2019; Reeves & Simperl, 2019). This is often performed annually or periodically. These types of projects do not require long term participation and are also able to determine trends in the populations of species.

#### 5.1.5 Motivation

The DBC frames that someone should participate if they enjoy butterflies or nature and have some prior knowledge or experience. All but one of the participants had some prior knowledge or experience related to butterflies or monitoring biodiversity. All participants stated enjoying nature, butterflies or participating. This demonstrates the considerable overlap in framing used by the DBC and its participants. A lack of prior knowledge is perceived as a barrier for new participants by a participant who admitted they did not have much knowledge prior to participating. This cognitive dissonance demonstrates that the project framing may have influenced their perception of what barriers exist for participating.

The only aspect that differs between the DBC and its participants is that the DBC mentions protecting butterflies so that future generations may enjoy them, which is not mentioned by participants. The emphasis placed on monitoring especially over a long time period used by the DBC is reflected by participants stating this as a reason to continue to participate. The worth of their participation has been linked to performing their task over a long time period. There are other similar projects, for example *Waarneming*, which do not require participating over a long time period to achieve the same purpose (wildlife monitoring).

The similarities between the design and framing of a project and the motivations of participants is common in research. For example, Foldit participants were most motivated by contributing to science (Curtis, 2015). A prominent banner on the homepage of Foldit states: “click to learn how you contribute to science by playing Foldit” (Foldit, n.d.). Other motivations included social interaction with other participants, and the gamification aspects of the game (Curtis, 2015). The design of the project involves puzzles which participants solve in teams to gain points. Simperl et al (2018) concluded from a systematic literature review that story based, collaborative and implementations of gamification that support

intrinsic motivations are preferred over implementations such as points systems, which support extrinsic motivation. When coordinators would try to change the project, regardless of the reason, participants would complain. The participants had become attached to the current design and framing of the project, and reject others.

## 5.2 How can the framing and design of a project act as a selection process?

All participants had some interest or experience relevant to the project. The framing used by the project in recruiting participants states that participants should have prior knowledge. This unsurprisingly suggests that stating participation requires prior knowledge will select participants that meet this requirement. What is more interesting is there was one participant who stated not having prior knowledge. This participant viewed a lack of prior knowledge as a barrier for participation in their effort to recruit new participants. A participant who did not have prior knowledge, and became a successful participant, still viewed a lack of knowledge as a barrier for others. This suggests that the framing may act as a selection process even when the framing is false.

The design of the project entails a high upfront commitment to joining. Participants are personally visited by a DBC staff member upon signing up. This is likely precluding casual participants from joining as there is not an option for just trying it out for an afternoon. This high upfront commitment may explain the high retention rate reported by DBC staff. Due to the design of the project, only highly committed participants are selected to join. The step wise recruitment process and targeting of individuals with particular interests also acts as a selection process. The step wise recruitment process involves participants first becoming interested in the DBC and subscribing to their newsletter before the project actively attempts to recruit them for the CS project. Individuals that have compatible interests or hobbies, such as nature or photography, are targeted for recruitment. Together this means that participants will likely already have similar framings to that of the project.

The project does not frame itself as an activist project. This is also present in the participants; they do not see themselves as activists. It is possible that the framing used by the project acts as a selection process. Those who prognose activism would choose other initiatives, while those who believe in science and conservation select the DBC. The strong emphasis on science seems to attract individuals who also hold positive attitudes towards science or are science professionals. More than half of the interviewees stated having a positive attitude towards science prior to participating or were science professionals.

It is common for CS participants to have prior experience or interest in the subject. This relationship is found across a variety of projects. In a project that classifies medical research, Noel-Storr (2019) found that many of the participants work, teach or study within the medical field. In Foldit, a CS game with a purpose, Miller et al (2019) found a correlation between participation and prior knowledge about the subject or prior experience with gaming. Church et al (2019) found the majority of participants had prior experience in CS projects or environmental volunteering. Krebs (2010) found most participants in two distributed computing projects had jobs in IT or studied IT. A meteorological CS project had participants that commonly had prior knowledge or experience in meteorology (Lin, Bates & Goodale, 2016). It is possible therefor, that the framing used by the project does not act as a selection process. Instead, those with prior experience or interest are more likely to seek out and participate in CS projects.

### 5.3 How can the framing and design of a project influence how individuals frame their participation?

The similarities between the project framing and participant framing is so strong it is likely it is influenced by the project. This is especially strong for what is not mentioned. Neither the project nor participants assign blame to direct actors and instead refer to general processes such as pollution. For what is mentioned, there is an emphasis placed on contributing long term as a necessary strategy by the project framing. This is reflected by participants who also strongly emphasized the importance of long-term participation. This is likely related to the project design. The weekly collection of data, with routes covering most of the country requires regular and long-term volunteers. An alternative, such as bio-blitzes, where data is collected less frequently but by large number of participants, would be more suitable for short term participants. This suggests a link between the project framing and design. The way the project is framed must be suitable for how the project is designed and this in turn influences how participants frame their participation. What demonstrates the influence of the project design and framing on participants is that participants frame the methods used by the project as necessary for achieving the goals of the project. However, as demonstrated by other projects, such as bio-blitzes, and waarneming.nl alternatives exist that achieve similar goals.

Participants are only involved in collecting data and this is reflected in how they frame their participation. They do not mention how the data is used to protect butterflies and only one participant mentions trying to work with landowners. Participants mostly discussed reasons for participation that are directly related to the aspect of the project they are involved in, namely data collection. This is clear based on importance of long-term data collection voiced by most of the participants. It is further supported by the lack of mentioning how the data is used. It could be possible for participants to state they participate because of certain conservation goals which have been reached by the DBC. For example, that several butterflies species have become listed on the endangered species list and are protected. However, this is absent from the framing used by participants. Since the participants are not directly involved in this stage of the project, they also do not frame their participation accordingly.

These similarities in framing between the project and the participants also existed for participants who had not been participating as long. If the framing does influence participants, this is likely mostly occurring early on in participation for the DBC project. With the methods used, it is difficult to determine when this influence is occurring. It is possible that most of similarities occur due to a selection bias rather than an influence of the project framing and design.

That framings differ between initial and long term participants is supported by literature. Of a sample of 15 studies that compare differences in motivations between initial participants and longer-term participants 11 found differences (Alender, 2016; Aristeidou, Scanlon & Sharples, 2017; Carballo-Cárdenas & Tobi, 2016; Cox et al, 2018; Domroese & Johnson, 2017; Ferster et al, 2013; Frensley, 2017; Geoghegan et al, 2016; He et al, 2019; Jennett et al, 2016; Joseph et al 2019; Larson et al, 2020; Ng, Duncan & Koper, 2018; Rotman et al, 2012; Rotman et al, 2014). Unlike as theorized by Rotman et al (2012) the changes in motivations do not appear to be consistent between projects. He et al (2019) and Cox et al (2018) found that long term volunteers were less motivated by learning, whereas Carballo-Cárdenas and Tobi (2016) found long term participants were more motivated by

learning. Rotman et al (2012) found that initial participants were not motivated by altruism, however He et al (2019) found that altruistic motivations were similar between initial and long term participants. Domroese and Johnson (2017) found long term participants were more motivated by contributing, while Jennett et al (2016) found that initial participants were motivated by contributing, and continued participation was based on having interest, self-efficacy, and available time.

Although no research thus far has explored the influence of project framing on participant, there is evidence of its influence in literature. An example of the influence of framing can be seen from the different reactions to gamification in CS between two different projects as researched by Ponti et al (2018). Those participating in a project where the coordinators negatively framed gamification also viewed gamification as negative, whereas those participants in a project that positively framed gamification also viewed gamification as positive.

Another example from the literature is on participants from two gamified CS projects: EyeWire and Foldit. Initial participants were motivated by intrinsic and altruistic motivations, and gamification did not appear significant for them (Iacovides, et al 2013). Long term participants were motivated by the game elements of the projects. These motivations became highly specific over time. Simperl et al (2018) note that long term players reacted negatively to any changes that were made to the gamification elements. The current design and framing had become motivating to them and changes in this caused issues. What is significant is that initial participants were not found to be highly motivated by gamification. This is highly suggestive that the design and framing of the project influenced the framing and behaviour of participants.

Framing influencing how participants react to interventions and their stated motivations can partially fit into Crowston & Fagnot's (2008) motivational arc of participation. This theorizes that long term participants have a higher identification with the project ideology. It also fits within Legitimate Peripheral Participation theory (Lave & Wenger, 1999) which hypothesizes that participants choose to join, learn how to participate and speak about a project based on observing current practices of long-term participants.

## 5.4 Conclusion

The main research question of this thesis was:

*What is the relationship between the framing and design of a project and how participants frame their participation?*

Based on the literature review and the framing analysis, the framing and design of projects can influence participants' framing and act as a selection process. This has been demonstrated by answering the sub-questions in sections 5.1-5.3. There are strong similarities between the framing used by participants and the project. This suggest that either the project framing acts as a selection process or is influencing participants. There is evidence for both from the literature review and the framing analysis.

Based on the framing analysis of participants from the DBC, the influence of project framing and design primarily occurs through acting as a selection process. Participants already showed interest and had some relevant knowledge or experience prior to participating. The aspects of participants' framing that was influenced by the project appeared to be more incidental aspects such as the strategies that should be used. For

example, participants considered long term participation and data collection important for their continued participation. This was not mentioned as a reason for joining.

This relationship, where framing primarily influences participants through selection, is also reflected in the literature. Simperl et al (2018) found that participants became attached to the gamification elements used. This relationship may be specific to the DBC and similar projects. The project requires a large upfront commitment, and the project recruits participants from specific populations. This results in participants that already have similar framings, and only details specific to the project would be influenced. In the case of the DBC this is seen through the importance participants place on monitoring over long timer periods.

### 5.5 Future Research

The consequences for results from prior research are significant. The clear consequence is that results based on the perceptions of participants are likely influenced by the design and framing of the project they participate in. Any results obtained therefor, would be a reflection of how the project is framed and designed rather than best practices or how the project can solve participation challenges.

Based on the results of the framing analysis, with supporting evidence from the literature review the following hypothesis were developed.

Project framing and design will act more as a selection process for projects:

- that require a higher upfront commitment;
- that require the completion of more complex tasks;
- that recruit from a specific population.

Project framing and design will influence participants more:

- for less significant aspects of framing such as specific strategies or tactics;
- within the first year of participating;
- for projects that have more specific framing.

Future research will be required to confirm the arguments laid out in this conclusion and test the hypothesis developed. To confirm the arguments, framing analyses should be applied to different CS projects and with larger sample sizes. Beyond more research there are a few specific directions that may further our understanding of the influence of project framing and design on participation. To determine if project framing and design can act as a selection process, comparative research should be performed between participants who choose not to participate, or stop participating and those who decide to participate or continue participating. To determine if project framing and design influence participation two methods stand out. First, ethnography may be a suitable method, as participants could be followed over time to see how their framing evolves. This would further our understanding on how and if project framing and design influences participants. Second, intervention type research could be performed where different frames and designs for a project are compared to experimentally determine their effect. It is important that the sample of participants for this type of research consists of target participants. As shown in the literature review, different demographics react differently to projects (see p. 27).



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