Does Taking Simple Physical Actions Drive Engagement?

A Study of Gamification for Climate Action

Quentin Prideaux

A Thesis in the Field of Sustainability
for the Degree of Master of Liberal Arts in Extension Studies

Harvard University

May 2022
Abstract

Though the climate crisis has been understood by US and global scientists for decades, action by the US and global public has not matched the urgency of the issue and existing interventions have not induced a majority of people to make the individual, and systemic, changes necessary to effectively mitigate climate change.

This research was developed to better understand if and how individuals might be more inclined to personally engage in the mitigation of climate change through a gamification platform and direct investigation of the hypothesis that “We act ourselves into thinking differently more easily than we think ourselves into acting differently.” Specifically, the research built upon a game platform, SaveOhno, co-designed by the author in 2016 that sought to engage college students with the climate crisis and other sustainability issues. Previous work with students and SaveOhno had seemed to show positive correlations between students taking repeated, simple, physical actions to reduce greenhouse gas emissions in the gamified platform and the students’ rising sense of self-efficacy as agents of reducing global climate change.

This new experiment was again conducted through the SaveOhno gamification platform and engaged 92 US college students over three weeks in Spring 2021. Research participants were asked to perform up to 17 challenges, 10 of which included a simple physical action related to mitigating greenhouse gas emissions, then responded to a series of questions as to their level of engagement, and perceptions of self-efficacy, in mitigating climate change. All research participants were surveyed pre-test for
experimental variables (demographics, prior commitment, and climate knowledge), and surveyed pretest and posttest for levels of engagement (disposition and emotional associations). Feelings of self-efficacy were also surveyed using a climate engagement framework created by the Yale Program on Climate Change Communication (YPCCC).

Despite previous SaveOhno gamified engagements seeming to show positive results of mind-body connections regarding climate mitigation behaviors, this experiment using careful methodology and data analysis, found no significant and reliable differences between the pre-test and post-test surveys of research participants. Specifically, this experiment did not find any significant results showing that simple, physical actions taken by individuals to combat or mitigate climate change had any measurable effect on their sense of self-efficacy in overall mitigation of the global climate crisis. This result was consistent regardless of whether the data were parsed for the whole cohort of participants or according to subsets of experimental variables.

While the results of this research program did not support the initial hypothesis, a review of parallel disciplines of behavior and mental state modification related to physical engagement suggests that it is still reasonable to expect a positive correlation and effect. In fact, the lack of result in this study more likely suggests gaps in the experimental design or research execution that should be addressed in future studies to better understand potential correlation. As such, several adjustments to the study are discussed and analyzed. Two key updates to future research would include increasing the number of interventions as well as the overall time period of the game in order for significant results to be measured.
Acknowledgments

I am deeply indebted to my thesis director, Dr Melody Burkins, for the support, guidance, education, and insight into academic thinking I received in our very enjoyable thesis sessions. Dr Mark Leighton, my research advisor, and Jen Palacio set me up for success with their positive, patient, and thorough thesis preparation. Progress would have been so much harder without the Teachers Assistants, librarian George Clark, amazing academic advisor Lacey Klingensmith, and the other thesis, math, writing, and IT support services. My ability to begin a thesis was built upon the learning obtained from the exceptional professors in the Harvard Division of Continuing Education’s Sustainability faculty over the past years. It was a joy and additional education to study alongside the fun and dedicated students I met at all stages. I am a little sad to be closing those dozens of open browser tabs.

My family encouraged me throughout and lovingly listened to my technical musings, concerns about progress, and excited leaps into new ideas. I am fortunate.
# Table of Contents

Acknowledgments ..................................................................................................................... v  

List of Tables ............................................................................................................................. ix  

List of Figures ............................................................................................................................ x  

I. Introduction ............................................................................................................................. 1  
   Research Significance and Objectives ....................................................................................... 3  
   Background ............................................................................................................................... 4  
   Public Engagement with the Climate Crisis ............................................................................. 4  
      Public Engagement and Action to Mitigate Climate Change has not Matched the Urgency of the Issue ........................................................................................................... 6  
      Behavior Drives Individual and Systemic Change ................................................................. 7  
      Is the Climate Crisis a Uniquely ‘Wicked’ Problem? ......................................................... 8  
   Cognitive Theory ..................................................................................................................... 10  
      Social Cognitive Theory ....................................................................................................... 10  
      System 1 and System 2 Interventions ............................................................................... 15  
      Climate Interventions and Cognitive Theory .................................................................. 16  
   Accessing A New Mode of Influence With Gamification ...................................................... 18  
      Current Gamification Approaches for Climate & Sustainability: Key Limitations ............. 20  
      Rewarding engagement: points, badges and leaderboards .............................................. 21  
      Self-reporting green actions ............................................................................................. 21  
      Utility energy competitions ............................................................................................... 22
Measuring Impact on Engagement .......................................................... 23

Research Questions, Hypotheses, and Specific Aims .......................... 24

Specific Aims of Research and Study Design ..................................... 25

II. Methods .......................................................................................... 26

Gamification Platform ......................................................................... 26

Gamification Elements in SaveOhno .................................................. 27

Competition Administration ............................................................... 29

Controlled use of Simple Physical Actions ....................................... 30

Entry and Exit Surveys ........................................................................ 33

Engagement and Emotional Associations ......................................... 34

Self-Efficacy ....................................................................................... 35

Recategorization ................................................................................ 36

III. Results .......................................................................................... 38

Data Analysis ..................................................................................... 38

Low Commitment vs High Commitment .......................................... 39

Engagement with the Climate Crisis ............................................... 39

Existence of global warming ......................................................... 40

Harm caused by global warming ..................................................... 42

Emotions associated with global warming ..................................... 45

Human and personal responses ....................................................... 49

Self-Efficacy ....................................................................................... 51

Significant Results ............................................................................ 53

IV. Discussion ...................................................................................... 55
Engagement with the Climate Crisis

Self-efficacy

Existence of a Link Between Simple Physical Actions and Mental State

Experimental Design and Execution

Use of a Pure Control

Size and Makeup of Populations

Number and Duration of Interventions

Inclusion of Multiple Sustainability Dimensions and Non-Action Challenges

Use of Gamification

Self-Efficacy Scale

Questions For Further Research

Conclusions

Appendix 1 Survey Instrument

Appendix 2 Participants’ Genders

References
List of Tables

Table 1. Experimental groups ..................................................................................................................31
Table 2. Example action with three different group presentations .......................................................32
Table 3. Experimental groups ..................................................................................................................38
Table 4. Emotions associated with global warming before and after the competition – all levels of prior commitment ..........................................................................................................................46
Table 5. Emotions associated with global warming before and after the competition – low levels of prior commitment ..........................................................................................................................48
Table 6. T-test of personal impact by group ..........................................................................................51
Table 7. T-test of overall self-efficacy by group .......................................................................................51
Table 8. T-test of self-efficacy sub-category by group ..............................................................................52
Table 9. Demographic survey questions ...............................................................................................66
Table 10. Past activity survey questions ..............................................................................................67
Table 11. Attitude and awareness survey questions ..................................................................................68
Table 12. Knowledge survey questions ..................................................................................................69
Table 13. Self-efficacy practice question ...............................................................................................70
Table 14. Self-efficacy survey questions ...............................................................................................71
Table 15. Consent survey questions ......................................................................................................72
Table 16. Physical challenges ..................................................................................................................75
Table 17. Non-physical challenges ..........................................................................................................77
Table 18. Participant gender distribution ...............................................................................................78
List of Figures

Figure 1. US public awareness and concern about global warming ........................................2
Figure 2. Four models of Social Cognitive Theory .............................................................12
Figure 3. Triadic reciprocity ...............................................................................................13
Figure 4. Author’s mapping of SCT models onto components of triadic reciprocity ......14
Figure 5. Author’s depiction of interventions to increase prosocial behavior in triadic 
reciprocity .......................................................................................................................17
Figure 6. Author’s depiction of interventions mediating cognitive and personal factors on 
behavior .........................................................................................................................18
Figure 7. Author’s depiction of interventions mediating behavior on cognitive and 
personal factors .............................................................................................................19
Figure 8. Utility bill received by the author .....................................................................22
Figure 9. SaveOhno web front page .................................................................................28
Figure 10. SaveOhno leaderboard (previous competition) .................................................29
Figure 11. List of challenges available to a student (previous competition) ......................30
Figure 12. Interventions experienced in the three groups .................................................32
Figure 13. Selfie uploaded by a student to certify their completion of the vegetarian meal 
challenge.. .........................................................................................................................33
Figure 14. Changes in ‘believed causes’ of global warming for all participants ..........41
Figure 15. Changes in ‘believed causes’ of global warming by group – all levels of prior 
commitment .....................................................................................................................41
Figure 16. Changes in ‘believed causes’ of global warming by group – low levels of prior commitment ........................................................................................................41

Figure 17. Changes in believed timing of global warming harm for all participants before and after the competition in comparison to YPCCC national data. ..............43

Figure 18. Changes in anticipated timing of global warming harm by group – all levels of prior commitment ........................................................................................................43

Figure 19. Changes in anticipated timing of global warming harm by group – low levels of prior commitment ........................................................................................................43

Figure 20. Changes in believed level of personal harm for all participants. .................44

Figure 21. Changes in anticipated level of personal harm by group – all levels of prior commitment ........................................................................................................44

Figure 22. Changes in anticipated level of personal harm by group – low levels of prior commitment ........................................................................................................44

Figure 23. Changes in emotions associated with global warming for all participants on a four-point Likert scale shown before and after the competition. .................47

Figure 24. Changes in categories of hopefulness by group – all levels of prior commitment ........................................................................................................47

Figure 25. Changes in categories of level of interest in global warming by Group – low levels of prior commitment ........................................................................................................48

Figure 26. Changes in beliefs about human response for all participants. .................49

Figure 27. Shifts between categories anticipated human response by group – all levels of prior commitment ........................................................................................................50
Figure 28. Shifts between categories anticipated human response by group – low levels of prior commitment .................................................................50
Chapter I
Introduction

Progress on the climate crisis has not yielded the emissions reductions necessary to avoid the worst effects predicted (United Nations Environment Programme, 2019). Without the broad engagement of the public, it seems unlikely that change can occur on the multiple fronts required to meet these goals. The consequences of this inaction are already being felt and will increase drastically in the coming years (Jackson, n.d.).

According to reports from the International Panel on Climate Change, effective reductions in greenhouse gas emissions must be achieved at many scales, including those of individuals, local groups and local governments, national bodies and national governments, and global institutions (IPCC, n.d.). All these levels are ultimately driven by the behavior of individuals in both their public and private capacities: individuals make decisions on purchasing and energy consumption and the support of individuals that empowers their representatives to make systemic changes. Unfortunately, in the US that level of support is insufficient and a majority of citizens see “global warming” as something that will only ever affect them “moderately” (Climate change in the American mind, 2021). The complex nature of the climate crisis itself is a factor that drives disengagement, added to the disininformation spread by the fossil fuel industry (Fueling the climate crisis, 2021). One potential explanation is that existing approaches to more directly engage a majority of the public have not yielded the results required for social change (Figure 1). Previous efforts in public engagement have focused on traditional
forms of communication: pamphlets, newspaper articles, formal education, interviews, and advertising (Rohling et al., 2016).

An interactive technique such as gamification applied to climate change engagement may increase individual and public engagement where traditional, less interactive techniques have failed. Gamification adds game-like elements to an ordinary task to encourage active participation in that task, including receiving some sort of positive feedback or reward (McGonigal, 2011). By focusing gamification on simple physical actions, we may be able to reverse the traditional path of influence, which is changing peoples’ intentions to affect their behavior and - instead - create a path that changes peoples’ behavior to affect their intentions.
Research Significance and Objectives

Starting in 2016, I co-developed a game platform designed to engage college students with the climate crisis and other sustainability issues. Our stated assumption was that “We act ourselves into thinking differently more easily than we think ourselves into acting differently.” The game, SaveOhno (n.d.), has been run at 12 colleges in the Northeastern US and seemed promising as a potential agent for social change. Yet our hypothesis -- that changing behavior and physical actions could lead to thinking differently and more positively about a global challenge -- had not yet been developed into a formal research project to test the idea and its potential application.

My research, therefore, was developed to examine the ability of using physical action to increase personal engagement with a global challenge -- specifically climate change -- through active gamification techniques that required simple physical engagement and reporting into the game platform for feedback and rewards. The hypothesis was that this approach might (1) reach those without a strong prior commitment to addressing the climate crisis, and (2) use simple physical actions to affect their level of engagement with, and sense of power over climate and related issues.

More specifically, the hypothesis was that, for individuals with very low or nonexistent engagement in an issue such as sustainability or climate mitigation, the act of taking a simple physical action related to those issues (such as eating vegetarian or recycling) through a gamification platform would enhance and increase that individual’s engagement with solving the crisis, and related self-efficacy, where self-efficacy is the belief in one’s own capacity to organize and guide the courses of action required to tackle certain situations in the immediate future (Wood & Bandura, 1989). If this behavioral
shift were found to be true, then this gamified technique might be applied in climate education and awareness interventions such as college courses, public awareness campaigns, and volunteer engagement. Furthermore, if successful with climate education and awareness, the approach may be applied to campaigns for other sustainability issues such as reducing waste or reducing environmental toxins, and species preservation. It may also be applied to other social goods such as increasing literacy, anti-racism, or social justice.

Key objectives for the study were to:

- Conduct a gamified intervention with a population of students which includes adding simple physical actions as the experimental variable.
- Measure any differential shift in the engagement and self-efficacy of students taking these simple physical actions during the game compared to those who do not.

Background

This research responds to the need for increased action by the American public on the climate crisis and investigated whether the areas of social cognitive theory and gamification point to the use of simple physical actions as a valid form of intervention for social good.

Public Engagement with the Climate Crisis

The first model of the impact of fossil fuel burning on the climate was created in 1896 by Svante Arrhenius. By 1903, Arrhenius had used the model to predict that a doubling of carbon dioxide (CO₂) levels in the atmosphere would lead to warming of 5-6
degrees C, a finding remarkably consistent with today's models. Living in chilly Sweden, Arrhenius felt that such a level of warming would be a good thing. Thereafter climate science progressed slowly and as few believed that a doubling of CO$_2$ from human activity would ever be possible, so little concern was felt both inside and outside scientific circles. As late as 1941, a report on “Climate and Man” from the US Department of Agriculture still made no reference at all to climate change or global warming (United States Department of Agriculture, 2004).

Following the dramatic increase in emissions from post-WWII industrialization, studies in climate science began to forecast non-benign outcomes. Starting in the 1950s the science of climate change began to reach the general public, albeit in a very limited way. In 1958 an OSS Foundation public information film stated that thanks to the annual release of six billion tons of carbon dioxide we might one day view “the drowned towers of Miami through 150 feet of tropical water.” (OSS Foundation, n.d.). In 1965, President Johnson stated publicly that humankind had already "altered the composition of the atmosphere …through the burning of fossil fuels." (Corneliussen, 2015). However, these alarming messages were rare, and attention paid was fleeting.

During the 1960s and 70s scientific understanding continued to improve, and the steady increase in global atmospheric CO$_2$ levels was measured with great precision in Mauna Loa and Antarctica (The Keeling Curve, n.d.). Still, publicity was very sparse and a member of the general public could be excused for being completely ignorant of global warming.

Starting in the 1980s, concern in the scientific community began to increase significantly with findings that predicted potentially catastrophic impacts from
anthropogenic climate change (Hansen et al., 1981; Hansen et al., 1988). The principal contributor to those findings, James Hansen, painted a dire picture of the effects of climate change in testimony to the US Senate in June of 1988 where he asserted that “The greenhouse effect is here.” (United States, 1988). Front-page news stories of his testimony brought climate scientists’ dramatic predictions to the public (Shabecoff & Times, 1988). However, from the 1990s onwards general concern would not match scientific understanding of the crisis, despite much wider communication.

Public Engagement and Action to Mitigate Climate Change has not Matched the Urgency of the Issue

Dr. Hansen stayed within the bounds of scientific communication for the decade following his Senate testimony in 1988, but others began to publicize the importance of the climate crisis more widely (McKibben, 1990). These communicators were familiar with the subject and framed their communications in an educational style, covering the science of the greenhouse effect, the global threats presented, and the need for the ramp-down of fossil fuel consumption. Despite the increased availability of information, public concern remained low and government action was absent (Hansen, 2010).

In 2006 the documentary An Inconvenient Truth: A Global Warning, presented by former Vice President Al Gore was released (Guggenheim, 2006). In addition to the science, the film included graphic and disturbing images of climate-related disasters and the associated suffering. This form of communication aimed for a more emotional connection and tapped a different audience. Public awareness and concern spiked between 2006 and 2008 following the documentary but this increase in interest had fully subsided within three years (Figure 1).
The years since 2009 have included increasing scientific confidence and specificity, greater levels of communication, and the widely reported impacts of an already-changing climate including floods, drought, heatwaves, hurricanes, and wildfires. Despite this mix of scientific communication and ongoing emotional appeals from interest groups, the US public’s levels of awareness and concern about climate only recently began to exceed their previous peaks in 2006 and 2007 (Figure 1).

In the US a majority (67%) currently believe global warming is an issue for future generations, but a minority (42%) believe it will harm them personally (Leiserowitz et al., 2020). The climate crisis’ enduring inability to rise to the top of the US public’s list of concerns seems to reflect a series of disconnects between an individual’s attitudes, their behavior, and the external influences that have been brought to bear on them.

Behavior Drives Individual and Systemic Change

We assume that individual behaviors and choices drive progress in all domains of change – political, commercial, and social, and at all scales from local to global. While we can distinguish system-wide change from changes made by one individual, we still recognize that, absent supernatural influence, all system change ultimately comes from individuals. Individuals elect politicians (The Constitution of the United States, 2015), run companies (FASB, 2009), and write laws (Frantzich, 1979). Personal responsibility is important but focusing only on one’s personal carbon footprint is insufficient (Timperley, n.d.) Even if many individuals choose to purchase renewable energy the remaining dirty electricity from coal and fracked gas would prevent us from achieving the necessary 100% drop in emissions by 2050 (US EPA, 2017).
In short, we may not need a few enthusiastic people doing everything they can. Instead, we may need a larger group of people engaging in the issues and making changes in enough different areas to shift the systems necessary for change.

Is the Climate Crisis a Uniquely ‘Wicked’ Problem?

Before we attempt to solve the climate crisis, we should consider whether it is a uniquely ‘wicked’ problem as has been claimed (Reidy, 2013). The original formulation of ‘wicked’ and ‘super-wicked’ problems cite five factors that work to block personal engagement and action: remoteness, uncertainty, guilt, futility, and loss. The great extent to which these factors exist in the climate crisis been said to make it a ‘super wicked’ problem that uniquely resists our abilities to both understand and solve it (Camillus, 2008; Lazarus, n.d.; Levin et al., 2012).

With the framing referenced above, the climate crisis does indeed present significant challenges in all five factors of a ‘wicked’ problem. Specifically:

- Remoteness
  - Threats can seem remote in time and space.
  - Outcomes are frequently spoken of as affecting grandchildren or those living near sea-level, rather than affecting the majority of those alive today. (Hansen, 2010)

- Uncertainty
  - Outcomes for an individual are highly uncertain.
  - Scientists talk of ranges of potential outcomes and cannot predict with certainty the effects on any geography (IPCC, n.d.).
• Guilt
  o Blame and feelings of guilt can be strong.
  o The average US resident has a carbon footprint far greater than the average human, which is itself too high to be sustainable (Goldstein et al., 2020).

• Futility
  o Personal action can seem entirely insufficient.
  o Changing one’s lightbulbs may reduce global emissions by a few tens of pounds of CO$_2$E (CO$_2$ equivalent -- greenhouse gasses with the equivalent climate impact of the stated number of pounds of CO$_2$), but a global reduction of billions of tons CO$_2$E is required (Liu & Raftery, 2021).

• Loss
  o The potential for failure threatens great loss.
  o Weather disasters, species extinctions, and sea-level rise generate feelings of great discomfort that accompany the prospect of loss (Kahneman & Tversky, 2013).

To be sure, these factors are shared by many, if not all, of the critical challenges facing our society (Crowley & Head, 2017; Turnbull & Hoppe, 2019). Some have argued, therefore, that “there is no special ontological class of ‘wicked’ problems” (Turnbull & Hoppe, 2019), but instead, simply two categories of problems: structured and unstructured. This argument suggests that structured problems are those of natural
science and are familiar in character, while unstructured problems are societal and will necessarily have varying degrees of the five factors and be 'wicked’ in nature.

Thus, in addition to being properly classified as “wicked,” containing all five factors to a high degree, the climate crisis can also be recognized as “unstructured.” That said, these classifications do not suggest that climate change is a uniquely wicked or intractable problem to which we must just resign ourselves. Though highly wicked and unstructured problems are, by definition, extremely challenging, they are neither intractable nor unsolvable (Turnbull & Hoppe, 2019).

Cognitive Theory

If we assume that there have been gaps, or failings, in how the American public is adequately engaged in mitigating the climate crisis, it is important to review concepts in the field of cognitive theory -- i.e., how information, thinking, internal states, acting, and behavior interrelate. This will lay the framework to better understand what we know about the process of human engagement overall and how this research -- using simply physical actions to influence a sense of self-efficacy -- is based in that theory.

Social Cognitive Theory

The relationships between an individual’s attitudes and behaviors, and the external influences upon that individual are studied in the field of Social Cognitive Theory (SCT) (Wood & Bandura, 1989). SCT investigates the type of influences present, the causal directions of influence, and intermediary factors on those influences. SCT developed from the four theories of; 1) Reasoned Action (RA), 2) the Theory of Planned
Behavior (TPB), 3) Norm Activation (NA), and 4) Values-Beliefs-Norms (VBN) (Wood & Bandura, 1989).

RA posits that the combination of a favorable attitude and congruent social norms lead to an individual’s intention, and that intention leads to appropriate behavior (Adjzen & Fishbein, 1980; Fishbein & Ajzen, 1977).

TPB expands on RA with the addition of ‘perception of control’ (Figure 2). In TPB the individual’s belief in their own ability is also a driver of behavior. TPB has been more successful than RA in predicting outcomes -- including in behavior around multiple environmental issues (Boldero, 1995; Sparks & Shepherd, 1992; Taylor & Todd, 1995).

In NA, ‘prosocial’ behavior becomes the focus. Prosocial behavior is that “intended to benefit others” (Jensen, 2016) and may or may not involve cost to the individual. NA factors in ‘awareness of consequences’ and ‘acceptance of responsibility’, as drivers of the individual’s personal norms and their resulting prosocial behavior (Schwartz, 1970, 1977) (Figure 2). In this theory the behavior is purely altruistic, with personal norms established from awareness of consequences for society as a whole, rather than from personal values (Schwartz, 1970, 1977) (Figure 2).

Finally in SCT, VBN theory builds on NA by theorizing that personal values drive prosocial behavior when those values are threatened and when the individual feels empowered to act (Stern et al., 1999) (Figure 2).

Each of these four theories describe different links between attitudes and behavior, and all these links are potential factors in the degree of US citizens’ engagement in the climate crisis.
The four SCT theories come together in the more general treatment of ‘triadic reciprocity’ where the previously noted factors and influences are grouped into three general domains of influence: 1) cognitive and personal factors, 2) behavior, and 3) external influences, all of which influence each other (Bandura, 1986) (Figure 3).
A mapping of the four SCT theories onto triadic reciprocity shows that they all posit combinations of external influences and cognitive and personal factors in ways that drive behavior (Figure 4). In RA, TPB, NA and VBN, behavior is the outcome of all other relevant factors. However, in triadic reciprocity each influence is recognized as bi-directional. By positing a bidirectional relationship, triadic reciprocity frees us to consider the effect of behavior on cognitive and personal factors, and whether this makes new interventions possible.
Figure 4. Author’s mapping of SCT models onto components of triadic reciprocity.

As we consider existing and potential interventions used in engaging the public with the climate crisis it is helpful to consider the two main ways in which external interventions are processed by an individual: through either ‘System 1’ or ‘System 2’ (Kahneman & Tversky, 2013). As we will see, these two Systems are forcing influences on the interventions that are available to us. How those Systems are engaged is an important factor in the effectiveness of an intervention.
System 1 and System 2 Interventions

Two modes of thinking have been found to be highly predictive of behavioral outcomes: “System 1” and “System 2” (Kahneman & Tversky, 2013). System 1 thinking is largely based on unconscious, gut-level reaction to immediate threats and, to a lesser extent, immediate opportunities. It operates quickly, providing a judgment almost instantaneously. System 2 thinking, however, is deliberative, combining past experiences and learning with new knowledge to reach a logical decision on how to act. System 2 delivers a more considered response but operates more slowly than System 1. Depending on the circumstances, either or both Systems may engage in shaping behavior. A high-pressure and emotionally charged situation might trigger System 1 and do so strongly enough for it to shut down the slower System 2 before the latter can engage with the issue. Alternatively, an important decision that an individual consciously prioritizes above a gut-reaction might engage System 2, overriding any immediate aversion presented by System 1.

Routine climate education and awareness campaigns target System 2 thinking through scientific information and logical arguments. Such messaging includes the science of the greenhouse effect, data on rising levels of atmospheric CO₂, and forecasts of resulting negative outcomes. Some of the most prominent communicators of the climate crisis started with the assumption that there is a one-way connection that starts with external influences and leads through attitude change to a change in behavior. This was stated by the noted scientist, activist, and author Bill McKibben describing his hope in 1988:
I think my assumption when I was 27 was that explaining rationally all the trouble we're in would be sufficient, and that politicians and whoever would act.” (Rustin, 2010).

However, these logical arguments may be rejected by System 1, particularly if they create an emotional response of being too hard, too new, too complicated, too unusual, or too scary (Kahneman & Tversky, 2013). Furthermore, a confounding factor for System 2 is the presence of counter-narratives generated by fossil-fuel companies (Oreskes & Conway, 2011). Scientists in fossil fuel companies were among the first to understand the implications of climate change in the 1980s and saw that reducing fossil fuel consumption would be necessary (Mann, 2014). However, rather than publicizing their knowledge it was kept in-house (Oreskes & Conway, 2011; Washington & Cook, 2011). Publicly fossil fuel companies used both System 1 and System 2 communications to obfuscate and confuse, much as the tobacco industry had done with the dangers of smoking tobacco (Oreskes & Conway, 2011; Washington & Cook, 2011).

Alternatively, in climate communications an appeal to personal values might be made with the image of a drowning polar bear, for example. This approach might trigger a strong emotional reaction even if it was not fully understood how and when a polar bear would suffer from climate change. However, while evocative for many (What one starving polar bear picture does — and doesn’t — say about climate change, n.d.) the feelings of guilt invoked by the suffering bear might even be counterproductive with some others (Bloodhart & Swim, 2014). System 1, therefore, also has its limitations.

Climate Interventions and Cognitive Theory

System 1- and System 2-based climate intervention operate in different areas of the triadic reciprocity model. Many of the usual climate interventions of publicity and
awareness campaigns are External Influences attempting to change Cognitive and Personal Factors (Figure 5). These can also be classified as putting campaigns into either System 1 (“polar bears are dying!”) or System 2 (“long term data shows we are in hottest year ever recorded”) framings.

![Diagram](image)

**Figure 5.** Author’s depiction of interventions to increase prosocial behavior in triadic reciprocity.

One alternative to the use of external influences, whether they are System 1 or System 2, is to reduce barriers to behavior consistent with existing cognitive and personal factors (Figure 6). This might be achieved by reducing the burden of the desired behavior
(reducing the cost of solar panels with incentives) or swapping the desired behavior for a less burdensome alternative (changing lightbulbs instead of changing the energy grid).

Figure 6. Author’s depiction of interventions mediating cognitive and personal factors on behavior.

The burden of action may also be reduced by making the targeted outcome the default and thereby ‘nudge’ the individual towards that behavior (Thaler & Sunstein, 2009). Nudges thus bypass System 2 and rely on an individual’s System 1 to take the easier and emotionally attractive option and ‘decide’ to leave things as they are, even if the individual was inclined toward an alternative option. The (prosocial) default may then to proceed unencumbered by System 2.

Accessing a New Mode of Influence with Gamification

By directly modifying an individual’s experience we may seek to reverse the order assumed in the four SCT models, a ‘one-way’ street ending with behavior, and instead activate the influence of behavior on cognitive and personal factors (Figure 7). There are many established implementations of this general approach including Operant
Conditioning (Pavlov, 1927), habit formation (Lally et al., 2010) and Active Learning (Prince, 2004). Gamification is also a potential vehicle for this activation and one that offers the opportunity to reach those with a low level of commitment to the issue at hand (Dichev & Dicheva, 2017; McGonigal, 2011; Rapp et al., 2019).

![Figure 7. Author’s depiction of interventions mediating behavior on cognitive and personal factors.](image)

In operant conditioning, interventions introduce a basic association with a simple condition (Skinner, 1932) though this type of conditioning is far simpler than the factors influencing behavior related to the climate crisis. In habit formation the subject has an active interest in forming or breaking a habit (Lally et al., 2010. The subjects are engaged and have stated intentions to change their behavior, whether it be to stop smoking, start exercising, or manage their anger. The participants, by definition, do not have a low commitment to their goal. Similarly, Active Learning is used where students and teachers are engaged and aligned with the intervention -- to increase the students’ learning and achievement. Given this knowledge, it seems to follow that all three of these types of
behavioral intervention are thus unsuited to the inducing change of mental state or behavior in a public with low commitment to the climate crisis.

The opportunity with gamification, therefore, is to effect change where the subject does not have a pre-existing goal or intention to change their behavior. As we have seen above, this is the situation with the climate crisis – a majority have a low level of commitment to creating change, even if they report a desire for that change to occur.

Playing a game is “the voluntary attempt to overcome unnecessary obstacles” and gamification is the process of adding game-like elements to an existing task to encourage participation in that task (McGonigal, 2011 p. 22). Since the first intentional uses of gamification in influencing behavior in 2010, it has been seen by some as a panacea capable of transforming everything from personal development, to work and education (McGonigal, 2011; Zichermann & Cunningham, 2011). While gamification may not be as powerful as its most enthusiastic proponents claim, it has been shown to increase learning and understanding of new fields (Betts et al., 2013; Dichev & Dicheva, 2017), to motivate behavior change (Garris et al., 2016), and have “significant small effects on cognitive…, motivational…, and behavioral learning outcomes” (Sailer & Homner, 2020, p1).

Current Gamification Approaches for Climate & Sustainability: Key Limitations

Implementation of gamification in climate and related sustainability issues can be usefully grouped into three main areas: 1) promoting pro-social environmental behavior with points, badges, and leaderboards; 2) promoting pro-social environmental behavior by publicly logging ‘green’ actions and 3) gamifying utility bills to reduce energy consumption (Sgueo, 2017). These three areas are discussed below, noting key
limitations in terms of their audience engagement and, importantly, any measured accountability for real-world behavioral change.

Rewarding engagement: points, badges and leaderboards. The standard gamification elements of points, badges, and leaderboards (Chou, 2015) are known to increase the rewarded behavior in many applications and can spread information effectively to a target group (Mazur-Stommen & Farley, n.d.). Games including Vermontivate, Cool Choices, Solipoints, and the now-defunct Climate Reality Project Climate Champions apply these three tools to affect users’ online behavior (Rapp et al., 2019). Players in these games comment on articles, absorb information, or otherwise take online actions and are rewarded with virtual points, public acknowledgement, and better ranking in a leaderboard. However, two important limitations exist to these current games: the self-selection of those who take part, and the relative ineffectiveness of the actions taken. Specifically, these games attract those already motivated to shine amongst their peers in green activism and may not engage the low- to non-engaged populations. In addition, the purely online engagement requires no physical change in a gamer’s behavior in the real world that can be quantified or shown to further real-world climate goals.

Self-reporting green actions. Multiple online games have used the public reporting of emissions-reducing actions to encourage more of this activity (Kukui Cup, n.d., Markham, 2013, JouleBug | sustainability app, n.d., Recyclemania, n.d.) had participants turn off faucets, eat vegetarian, adjust thermostats, take shorter showers, and similar actions. These actions are logged for points and non-monetary digital rewards. In these
games, there is a focus on real-world emissions reductions. However, this approach again is mostly likely to attract those already motivated to act. And, as actions are self-reported with no baseline as to what was done by the individual prior to playing the game, we cannot measure whether the game had any impact.

*Utility energy competitions.* Multiple studies have shown that simple gamification of residential energy usage can reduce users’ consumption (Mazur-Stommen & Farley, n.d.). Adding a smiley or frowny face to an electricity bill to illustrate consumption levels can change behavior and reduce consumption. These games are not self-selecting and reach all residents in a service area with a strong motivation to participate: saving money. As these games are focused on select populations currently paying for utility services, they not may be applicable to broader areas of climate and sustainability action.

Figure 8. Utility bill received by the author.
Self-efficacy is the belief in one’s own capacity to organize and guide the courses of action required to tackle certain situations in the immediate future (Wood & Bandura, 1989). Ways in which self-efficacy have been used in this field in the past include reinforcing messages such as “With that choice, you just saved the emissions of driving a car for a year”. This amplifies the message that the person is making a difference, is having an effect. Previous research has used self-efficacy scales to understand intentions in pollution reduction (Homburg & Stolberg, 2006) and recycling behavior (Tabernero & Hernández, 2011) and it has been shown that perceived self-efficacy as an independent variable is predictive of environmental behaviors (Meinhold & Malkus, 2005). Perception of self-efficacy has been shown to be predictive of environmental behavior whether an individual’s actions are efficacious in practice or not (Meinhold & Malkus, 2005). Going further, an efficacious individual may adapt their surroundings in a way that will then influence the individual in turn (Sawitri et al., 2015).

Self-efficacy is shown to be a mediating feature in SCT through path analysis, and is referred to as ‘perception of control’ in TPB and is related to “awareness of consequences” in NA and VBN (Wood & Bandura, 1989). In this formulation individuals are both “products” and “producers” of their environments. Goals, related actions, persistence, and the associated thoughts and feelings are all presumed to be affected by self-efficacy beliefs (Bandura, 2000). Triadic reciprocity uses the term “self-efficacy” specifically and theorizes that it drives behavior and iteratively drives an individual’s external influences.
In their investigation into SCT and pro-environmental behavior Sawitiri et al. (2015) conclude that:

Self-efficacy (beliefs about one’s ability to successfully organise and perform courses of action) fosters positive outcome expectations (beliefs about the consequences of given actions), and both, independently and jointly, lead to goals (intentions to engage in a particular activity). Goals, in turn, motivate pro-environmental actions.

As has been discussed, the climate crisis suffers from the low engagement of the majority, so if the intervention under investigation had an impact on that level of engagement, this would be an important finding.

Research Questions, Hypotheses, and Specific Aims

My central question and associated hypotheses explored the impact of taking physical action on students’ levels of engagement with the climate crisis and on their levels of self-efficacy.

- Question 1: To what extent does taking personal action shift college students’ engagement with the climate crisis?
  - Hypothesis 1A: Climate communication that includes relevant physical action has more than twice the impact on engagement of a non-action communication where engagement is measured by levels of optimism and interest.

My second question explored the underlying reasons for the effectiveness (or not) of action on changing engagement. It asks if the level of perceived self-efficacy is a factor and whether an increase in self-efficacy corresponds to the taking of physical actions. Given the novelty of this investigation no defined amount of change is anticipated, simply a positive or negative indication.
• Question 2: Does taking action increase perceived self-efficacy?
  
  o Hypothesis 2A: Increases in self-efficacy will correlate with increases in engagement.
  
  o Hypothesis 2B: Students taking physical action will have a greater increase in their levels of self-efficacy.

Specific Aims

  Completing the research required that I:
  
  1. Run a gamified climate and sustainability intervention with a group of college students.
  
  2. Survey the students before taking part on their disposition towards the climate crisis including their awareness, optimism, and belief in their personal efficacy.
  
  3. Separate students randomly into two groups and expose the control group only to educational climate messages, and the other to the same messages plus the requirement to take a simple and related action.
  
  4. Repeat the survey and capture data on any change in the responses.
  
  5. Measure changes in reported optimism, personal efficacy, and related measures of awareness and attitude.
  
  6. Generate an aggregate measure of levels of engagement from the survey questions.
  
  7. Measure shifts in aggregate score and component scores and analyze these for significant difference for those using active learning, and those not.
Chapter II
Methods

The core experimental methods for this research were: use of a gamification platform, controlled requirement of simple physical actions by participants, surveys of participants to evaluate their disposition before and after the intervention, and data analysis to interpret those data.

Surveys are a very common form of data gathering in gamification research -- comprising 65% of the 273 empirical gamification studies analyzed in one 2019 meta-study of the field (Koivisto & Hamari, 2019). The gamification platform was used to attract and retain students with varying levels of engagement with the climate crisis. Surveys were used to measure students’ demographics, self-efficacy, attitudes and awareness with respect to the climate crisis and their previous level of commitment to that crisis. In advance of the competition surveys were submitted to and approved by Harvard University’s Committee on the Use of Human Subjects.

Gamification Platform

This research used the gamification platform SaveOhno, which is designed to attract and engage college students in climate and other sustainability activities over a three-week period during a college semester (Figure 9). I co-developed this platform, starting in 2015. As noted in the Introduction, the intention with SaveOhno has been to engage students with the climate crisis on the untested belief that “We act ourselves into thinking differently more easily than we think ourselves into acting differently”. The
SaveOhno game has been run at 12 colleges in the northeast US, incorporating both standard and unique gamification elements to maximize its reach and impact.

The SaveOhno platform was developed to build on the previous gamification ideas discussed earlier, but to more intentionally focus on a less- or non-engaged audience. This experiment was structured to quantify any behavioral changes by using methods to test participants “self-efficacy” before and after engaging in simple physical actions within the game. Again, the hypothesis was that this emphasis on simply physical actions and change, rather than focusing directly on cognitive change, might allow a bypass of both Systems 1 and 2 thinking and move the participant directly to a new state of engagement. A participant in a game has little reason to resist taking a simple action that will earn them points, and the points are the focus of the action, rather than the action itself. If information is conveyed concurrently with those simple actions, it is possible that information will “piggy-back” on the action and become an accepted, integral part of the overall transaction both physically and cognitively.

Gamification Elements in SaveOhno

The standard gamification elements within SaveOhno are prizes, points, teams, and a leaderboard. Students are recruited to join a SaveOhno competition with prizes of Patagonia clothing, which is very attractive to students in the northeast US. Patagonia’s reputation in sustainability (Furbershaw, 2010; MacKinnon, 2015; Pierce, 2015) is also compatible with the principles of SaveOhno.
In a SaveOhno competition students earn points by their response to various activities presented on the platform over the period of three weeks. This duration was chosen because it was more popular with students than when a competition was run over either two or four weeks. Each student is presented with a series of challenges and awarded points for each one that is completed. Challenge completion points accumulate over the course of the competition and team points are a sum of the points of the team members. A new point-earning challenge is released approximately every day.

Students are invited to sign up in teams. The most motivated students within a team are incentivized to encourage their less motivated teammates to stay engaged because no team member can win a prize unless the entire team does.
A leaderboard shows the current status of the competition - which teams are in the lead and by how much (Figure 10). The leaderboard serves as an incentive for teams to maximize their points and move up the ranking.

![LEADERBOARD](image)

Figure 10. SaveOhno leaderboard (previous competition).

**Competition Administration**

The researched competition was already scheduled at Brandeis University for the spring of 2021 and was the fifth such program run there. Prizes were awarded as usual and were unrelated to any use of survey data for this research. Players were recruited by student ambassadors in the Brandeis Office of Sustainability using email, social media, and friend networks. The students were asked individually if they wished to take part in the research by making their data available for analysis. Only the author was aware of
who had consented, and no part of the competition differed in any way between those in the research cohort and those not. Challenges did not expire, and a dashboard showed each participant which ones they still needed to complete (Figure 11).

Figure 11. List of challenges available to a student (previous competition).

**Controlled Use of Simple Physical Actions**

A total of 17 challenges were issued to the students over the course of the competition. Ten of these included simple physical actions and were varied across the three experimental groups (Table 1). The remaining seven were non-physical in nature and not experimental variables.
Table 1. Experimental groups.

<table>
<thead>
<tr>
<th>Group</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Presented with rationale and prompted to take action</td>
</tr>
<tr>
<td>B</td>
<td>Presented with rationale only</td>
</tr>
<tr>
<td>C</td>
<td>Prompted to take action only</td>
</tr>
</tbody>
</table>

Group A (60% of participants) was presented with a rationale for taking a given action and clicked a button to acknowledge the rationale. They were then prompted to take the action and prove compliance by uploading a selfie.

Group B (20% of participants) was the control group in which participants were presented with the rationale for taking the listed action but not required to perform the action.

Group C (20% of participants) was prompted to take the action and prove compliance without being given any rationale. This group was not part of the original experimental design or hypotheses. It was added later to investigate whether physical activity alone could influence self-efficacy without being linked to any climate-related messaging or justification.
Figure 12. Interventions experienced in the three groups.

Each challenge was issued to every student at the same with the same title and content fitting the student’s experimental group. An example of the three different versions of a challenge is shown in Table 2.

Table 2. Example action with three different group presentations.

<table>
<thead>
<tr>
<th>Not shown to participants</th>
<th>Shown to participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>GROUP A</td>
<td>Plants 4 the win</td>
</tr>
<tr>
<td>Rationale</td>
<td>Experts agree that eating less meat and dairy products is vital to slow down climate change. The global livestock industry produces more greenhouse gas emissions than all cars, planes, trains, and ships combined! A report from the Intergovernmental Panel on Climate Change found that dietary change can “substantially lower” greenhouse gas emissions. Simply make your lunch or dinner meat-free and post a picture of you AND your meal - and it needs to be an actual meal, not a picture of a granola bar!</td>
</tr>
<tr>
<td>Instruction - take action</td>
<td>To get your points, share a selfie of you with a meat-free meal.</td>
</tr>
<tr>
<td>GROUP B</td>
<td>Plants 4 the win</td>
</tr>
<tr>
<td>Rationale</td>
<td>Experts agree that eating less meat and dairy products is vital to slow down climate change. The global livestock industry produces more greenhouse gas emissions than all cars, planes, trains, and ships combined! A report from the Intergovernmental Panel on Climate Change found that dietary change can “substantially lower” greenhouse gas emissions.</td>
</tr>
<tr>
<td>Instruction - click to acknowledge info</td>
<td>To get your points, click the button to acknowledge that you have read the information above.</td>
</tr>
<tr>
<td>GROUP C</td>
<td>Plants 4 the win</td>
</tr>
<tr>
<td>Instruction - take action</td>
<td>To get your points, share a selfie of you with a meat-free meal.</td>
</tr>
</tbody>
</table>
A complete list of physical actions (Table 16) and non-physical actions (Table 17) is given in Appendix 1. Participants were notified at the outset that they would be given different types of challenge, and each included the footnote “Note: participants are asked to do different things - some take selfies, some do not, it's the same and fair across all teams.”

All selfies (Figure 13) were for compliance with the individual challenge. Selfies were shown to other participants who could earn a small number of points by checking the photograph’s validity. Automatic comparison of uploaded photographs ensured that different students couldn’t upload the same photograph.

Figure 13. Selfie uploaded by a student to certify their completion of the vegetarian meal challenge. Vegetarian meals are recognized to advance climate mitigation given recognition of higher carbon emissions associated with meat-centric diets.

Entry and Exit Surveys

Engagement and self-efficacy were measured using surveys issued before and after the competition. Survey questions fell into four categories: 1) demographic, 2) prior
commitment 3) knowledge, engagement and emotional associations, and 4) self-efficacy. Full questions can be found in Appendix 1. The approach used was approved by Harvard University’s Committee on the Use of Human Subjects.

In the entry survey six identification questions established basic demographic data including age, gender, and the course of study being pursued (Table 9). In the exit survey only the email address was collected to match up responses.

Six questions were asked pretest and posttest to determine the individual’s past activity in climate action. The experiment was intended to judge whether the intervention has in impact on those with a low level of prior commitment. It would be significant if the self-efficacy of the high prior commitment students increased even further because of SaveOhno, but I assumed this would be less likely and focused on “low prior commitment” as a cohort for analysis.

In the entry survey four questions were asked on identifying greenhouse gasses, the level of warming understood to be ‘catastrophic’ and the reductions needed to avoid this (Table 12). This basic knowledge was intended to be a filter that could be used in data analysis. It could be determined whether those with low knowledge changed their disposition more or less than those with initially high knowledge.

At the end of the entry survey the correct answers to the questions were provided so all participants were equally informed in these areas.

Engagement and Emotional Associations

The experiment was designed to determine whether participants changed their levels of engagement with the climate crisis and their emotional responses to it as a result of taking simple physical actions in the SaveOhno competition. Ten questions were
posed, all copied with permission from YPCCC (Leiserowitz et al., 2020) (Table 11).

YPCCC regularly issues surveys globally to gauge awareness and disposition toward the climate crisis. A full list of is in Table 11, and representative examples include:

- Do you think that global warming is happening? (Y/N)
- How strongly do you feel each of the following emotions when you think about the issue of global warming? Worried / Interested / Helpless / Hopeful? (4-point Likert scale)
- How much impact can you personally have in the fight against climate change (check '0' if you believe no impact is required)? (0-10)

Self-Efficacy

To measure the impact of the simple physical actions, the experiment used existing measures of attitude and awareness toward the climate crisis and an author-developed scale of ‘self-efficacy. Existing questions were copied with permission from the Yale Program on Climate Change Communications (YPCCC) (Leiserowitz et al., 2020).

Given the timescale for this research, it was not feasible to measure students’ physical and cognitive engagement over an extended period following the competition to monitor behavioral changes. As such, it was necessary to generate a proxy for student engagement that was clear, universal, and could be measured both before and after the gamification experience. Therefore, I generated a scale of self-efficacy as a proxy for engagement with the climate crisis. It was necessary to develop a self-efficacy survey and
scale for climate action as no existing such could be identified before the experiment (and none have been identified since).

I generated the scale using the guidelines from the author and creator of the self-efficacy model, Albert Bandura (Bandura, 1986). Bandura provides many examples of experimental self-efficacy scales and consistent wording, measures, and structure were used to create the scale. A self-efficacy scale is straightforward to construct as it directly asks questions related to the respondent’s self-perception of ability to perform certain actions. In this case questions were created for four climate and sustainability categories: Climate Footprint (3 questions); Water Footprint (3 questions); Eating Vegetarian (4 questions); Talking to others about climate change (4 questions). The standard self-efficacy practice questions used to explain the process are shown in Table 13 and the full survey in Table 14.

Recategorization

Before experimental data was analyzed some students were recategorized into a new group to match their actual experience of the competition. Two factors made this necessary. First, a student in Group A could read the rationale for an action but then not proceed to complete the action. This is the identical experience to that of a member of Group B. This behavior was anticipated before the competition and could not be avoided as students were not forced to complete all elements of a challenge. In cases where Group A students experienced a majority of Group B-type tasks they were recategorized into Group B. Second, some students managed to participate in actions that they were not requested to perform or given the hyperlinks for. In this way some members of Group B
experienced a majority of Group A-type tasks and were recategorized into Group A. The ability for students to access these links was detected early on and halted.
Chapter III

Results

In this experiment 210 participants enrolled with SaveOhno, 180 consented to their data being used, and 103 of those completed the entry and exit surveys. Eleven participants were excluded from analysis because they had either participated in a SaveOhno competition before or took no part in the competition at all beyond completing the two surveys. Excluding these yielded a total population of N=92. The breakdown of this population across the three groups is shown in Table 3.

Table 3. Experimental groups.

<table>
<thead>
<tr>
<th>Group</th>
<th>Description</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALL</td>
<td>All Groups</td>
<td>92</td>
</tr>
<tr>
<td>A</td>
<td>Presented with rationale and prompted to take action</td>
<td>62</td>
</tr>
<tr>
<td>B</td>
<td>Presented with rationale only</td>
<td>19</td>
</tr>
<tr>
<td>C</td>
<td>Prompted to take action only</td>
<td>11</td>
</tr>
</tbody>
</table>

Data Analysis

Survey data was captured in the experiment in four categories: 1) demographic, 2) prior commitment 3) knowledge, engagement, and emotional associations, and 4) self-efficacy.

Demographic data was reviewed for clear results but were not part of the research plan. Gender data were collected but no significant results were found when comparing self-efficacy results from men and women. Members of other genders were too few for
analysis. All demographic questions are given in Table 9 and gender breakdowns are given in Appendix 2.

Low Commitment vs High Commitment

Six questions determined students’ previous commitment to action for climate and sustainability by asking whether they had volunteered with an environmental organization or taken other relevant actions such as volunteering for an environmental organization or attending an environmental march (Table 10). An aggregate score of previous commitment was generated by summing positive responses to the six questions and their components, giving a score between 0 and 12. A cut-off level of 7 or lower was chosen to distinguish those with “low” prior commitment as this divided the cohort in roughly similar sizes and qualitatively distinguished between those who had taken many prior environmental actions and those who had not. The low prior commitment cohort numbered 42, leaving 50 with a high prior commitment. Data analysis was performed separately on the low prior commitment cohort.

Investigative analysis was also performed on six other cut-off levels (0, 2, 4, 6, 8, and 10) to determine if those levels revealed different patterns of responses.

Engagement With the Climate Crisis

Engagement with the climate crisis covered the student’s understanding of the cause(s) of the climate crisis, its potential harms, their emotions with respect to the climate crisis, and their opinions on possible human responses. The full language for each survey question asked is shown in Table 11.
Existence of global warming. In response to the question “Do you think that global warming is happening?” there was no change in the percentage responding “Yes” after the competition (99%) compared to before, with 1% responding “Don’t know”. Pretest and posttest responses depart significantly from the national data from YPCCC in 2021 where 70% responded “Yes”, 15% responded “Don’t know” and 15% responded “No” (“Climate Change in the American Mind, March 2021,” n.d.).

On the basic cause(s) of global warming (Table 11), the students reported a strong belief that human activities were the main cause. Figure 14 shows the before and after responses on this question across all participants regardless of group and compares this data with the national results from YPCCC. Before the competition 79% reported that humans were the main cause of global warming and 72% said so afterwards. The US population as a whole in 2021 believed in human causes (57%) and also in natural causes (30%) (Climate change in the American mind, 2021, n.d.).

The drop in the belief in human causes was seen in all groups, with a greater drop in the two groups taking simple action, A and C (Figure 15). In the low prior commitment cohort a drop was seen in all three groups (Figure 16).
Figure 14. Changes in ‘believed causes’ of global warming for all participants.

Figure 15. Changes in ‘believed causes’ of global warming by group – all levels of prior commitment.

Figure 16. Changes in ‘believed causes’ of global warming by Group – low levels of prior commitment.
Harm caused by global warming. The first of two global warming ‘harm’ questions asked when harm was anticipated to start. There was a slight shift toward ‘right now’ (+4%, 84% to 88%) and away from most longer timeframes (Figure 17). A larger increase was seen in the low prior commitment cohort (+8%, 75% to 82%). Broken down by group at all levels of prior commitment the shift was strongest in Group C (+9%) followed by Group A (+5%) with Group B showing no change (+0%) (Figure 18). Broken down by Group at low levels of prior commitment the shift was strongest in Group B (+9%) followed by Group A (+8%) with Group C showing no change (+0%) (Figure 19).

The second ‘harm’ question asked how much global warming would harm the respondent personally. There was a slight shift toward the categories of greater personal harm, with the two responses of “A great deal” and “Moderate” together increasing from 71% to 78% (+7%) (Figure 20). Broken down by group for all levels of prior commitment the shift of these two categories together was strongest in Group B (+16%) followed by Group C (+9%) and Group A (+5%) (Figure 21). Broken down by group for low levels of prior commitment the shift of these two categories together was strongest in Group C (+33%) followed by Group A (+13%) and Group B (+9%) (Figure 22).
Figure 17. Changes in believed timing of global warming harm for all participants before and after the competition in comparison to YPCCC national data.

Figure 18. Changes in anticipated timing of global warming harm by group – all levels of prior commitment.

Figure 19. Changes in anticipated timing of global warming harm by group – low levels of prior commitment.
Figure 20. Changes in believed level of personal harm for all participants.

Figure 21. Changes in anticipated level of personal harm by group – all levels of prior commitment.

Figure 22. Changes in anticipated level of personal harm by group – low levels of prior commitment.
Emotions associated with global warming. Four questions asked students “How strongly do you feel each of the following emotions when you think about the issue of global warming?” (‘worried’, ‘interested’, ‘helpless’, and ‘hopeful’). The mode and median of each “emotion” question for all participants at all levels of engagement are shown in Table 4. Charts of the responses for all participants before and after the competition are shown in Figure 23. The response categories are reversed for “helpless”, so that all four scales increase in engagement from left to right. A summary of the results of each question follows:

- **Worried**: the proportion reporting feeling very worried increased slightly from 76% to 79%, with an associated drop in the other, lower worry, categories. The mode and median responses were unchanged.

- **Interested**: The proportion reporting feeling very interested increased slightly from 51% to 59%, with an associated drop in the other, lower interest, categories. The mode and median responses were unchanged.

- **Helpless**: The greatest proportion (64%) reported feeling moderately helpless before the competition and this fell to 52% afterwards. However, increases were seen on each side of this factor, with increases in “very helpless” (from 25% to 33%) and also “not very helpless” (from 9% to 13%). The mode and median responses were unchanged.

- **Hopeful**: The greatest proportion (52%) reported feeling “not very hopeful” before the competition and this was still the modal response afterwards (45%). However, the median response changed from “not very hopeful” to the point between “not very hopeful” and “moderately hopeful”, with exactly half of the
respondents above and below this point. In Group A, a shift was seen from the two categories of lower engagement towards the two showing higher engagement. Group B showed a reduction in the middle two categories and an increase in the extremes. Group C showed a shift from “Not at all” to “Not very” (Figure 24). At low levels of prior commitment there is no shift seen in the median “hopeful” response as there was for all participants (Table 5).

Table 4. Emotions associated with global warming before and after the competition – all levels of prior commitment.

<table>
<thead>
<tr>
<th>How strongly do you feel ...</th>
<th>Mode</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before</td>
<td>After</td>
</tr>
<tr>
<td>...worried?</td>
<td>Very</td>
<td>Very</td>
</tr>
<tr>
<td>...interested?</td>
<td>Very</td>
<td>Very</td>
</tr>
<tr>
<td>...helpless?</td>
<td>Moderately</td>
<td>Moderately</td>
</tr>
<tr>
<td>...hopeful?</td>
<td>Not very</td>
<td>Not very</td>
</tr>
</tbody>
</table>
Figure 23. Changes in emotions associated with global warming for all participants on a four-point Likert scale shown before and after the competition.

Figure 24. Changes in categories of hopefulness by group – all levels of prior commitment.
There was a shift in both the mode and median response in response to the “interested” question. The greatest proportion (45%) reported feeling “Moderately interested” pretest and posttest the modal response (51%) was “Very interested”. The median response also changed from “Moderately interested” retest to “Very interested” posttest (Table 5). In Group A, a shift was seen just from “Moderately” to “Very” interested. Group B showed a reduction in “Not very” and increase in “Moderately” and “Very” interested. Group C showed no change (Figure 25).

Table 5. Emotions associated with global warming before and after the competition – low levels of prior commitment.

<table>
<thead>
<tr>
<th>How strongly do you feel ...</th>
<th>Mode</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>...worried?</td>
<td>Very</td>
<td>Very</td>
</tr>
<tr>
<td>...interested?</td>
<td>Moderately</td>
<td>Very</td>
</tr>
<tr>
<td>...helpless?</td>
<td>Moderately</td>
<td>Moderately</td>
</tr>
<tr>
<td>...hopeful?</td>
<td>Not very</td>
<td>Not very</td>
</tr>
</tbody>
</table>

Figure 25. Changes in categories of level of interest in global warming by group – low levels of prior commitment.
Human and personal responses. There were two questions on human responses to climate change. The first presented a range of options for humanity’s response and whether a sufficient response was technically possible and likely to be enacted. On humankind’s anticipated response there was a shift toward ‘Humans can reduce global warming, and we are going to do so successfully’ (+4% from 7% to 11%) and away from ‘Humans could reduce global warming, but it’s unclear at this point whether we will do what’s needed’ (-6%, from 61% to 55%). Broken down by group for all levels of prior commitment the increase in ‘…and we are going to do so successfully’ was strongest in Group A (+6%), with Groups B and C showing no change. All groups showed movement between the two responses of 1) ‘Humans could reduce global warming, but it’s unclear at this point whether we will do what’s needed’ and 2) ‘Humans could reduce global warming, but people aren’t willing to change their behavior, so we’re not going to’ (Figure 27).

![Effectiveness of Human Response](image)

Figure 26. Changes in beliefs about human response for all participants.
Figure 27. Shifts between categories anticipated human response by group – all levels of prior commitment.

Broken down by group for low levels of prior commitment the increase in ‘…and we are going to do so successfully’ was strongest in Group B (+9%), with Group A next (+3%). Groups A and B also showed movement between the ‘…unwilling…’ and ‘…unclear…’ responses, and Group C showed no net shift in any responses, though some Group C individuals did respond differently posttest to pretest (Figure 28).

Figure 28. Shifts between categories anticipated human response by group – low levels of prior commitment.

The second human response question asked how much impact the personal response of the participant could have on a 0-10 scale. Taking the group as a whole there was no significant change in personal impact belief after the competition (M = 5.65, SD =
2.41) compared to before the competition ($M = 5.58, SD = 2.30$), $t(91) = -0.29$, $p = .77$.

Furthermore, none of the three groups showed a significant difference in posttest and pretest personal impact (Table 6).

Table 6. T-test of personal impact by group.

<table>
<thead>
<tr>
<th>Personal impact</th>
<th>M</th>
<th>Std. Err.</th>
<th>t</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>All students</td>
<td>0.08</td>
<td>0.01</td>
<td>-0.29</td>
<td>91</td>
<td>0.77</td>
</tr>
<tr>
<td>Group A: info. and action</td>
<td>-0.06</td>
<td>0.02</td>
<td>0.21</td>
<td>61</td>
<td>0.84</td>
</tr>
<tr>
<td>Group B: info only</td>
<td>0.05</td>
<td>0.02</td>
<td>-0.09</td>
<td>18</td>
<td>0.93</td>
</tr>
<tr>
<td>Group C: action only</td>
<td>0.91</td>
<td>0.01</td>
<td>-1.10</td>
<td>10</td>
<td>0.30</td>
</tr>
</tbody>
</table>

Self-Efficacy

There was no significant difference in self-efficacy in the whole population after the competition ($M = 100.8, SD = 18.7$) compared to before the competition ($M = 100.4, SD = 17.6$), $t(91) = -0.29$, $p = .77$ (Table 7).

Furthermore, none of the three groups showed a significant difference in posttest and pretest self-efficacy (Table 7). Dividing the full cohort into different levels of prior commitment did not change this overall result, regardless of where the division between high and low prior commitment was set.

Table 7. T-test of overall self-efficacy by group.

<table>
<thead>
<tr>
<th>Pretest - Posttest Self-efficacy</th>
<th>M</th>
<th>Std. Err.</th>
<th>t</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>All students</td>
<td>0.43</td>
<td>0.11</td>
<td>-0.29</td>
<td>91</td>
<td>0.77</td>
</tr>
<tr>
<td>Group A: info. and action</td>
<td>-0.43</td>
<td>0.29</td>
<td>0.19</td>
<td>43</td>
<td>0.85</td>
</tr>
<tr>
<td>Group B: info only</td>
<td>-0.43</td>
<td>0.09</td>
<td>0.15</td>
<td>20</td>
<td>0.88</td>
</tr>
<tr>
<td>Group C: action only</td>
<td>0.10</td>
<td>1.29</td>
<td>-0.02</td>
<td>9</td>
<td>0.98</td>
</tr>
</tbody>
</table>
Further analysis was performed on the four sub-categories of self-efficacy: carbon footprint, water footprint, eating vegetarian, and communication. No significant differences were found between pretest and posttest results for any of the four sub-categories, either in the whole population or the three Groups (Table 8). Dividing the full cohort into different levels of prior commitment did not change this overall result, regardless of where the division between high and low prior commitment was set. With such high p-values across the dataset it was thought redundant to perform ANOVA analysis.

Table 8. T-test of self-efficacy sub-category by Group

<table>
<thead>
<tr>
<th>Pretest - Posttest Carbon Footprint Self-efficacy</th>
<th>M</th>
<th>Std. Err.</th>
<th>t</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>All students</td>
<td>0.43</td>
<td>0.11</td>
<td>-0.29</td>
<td>91</td>
<td>0.77</td>
</tr>
<tr>
<td>Group A: info. and action</td>
<td>-0.06</td>
<td>0.23</td>
<td>0.04</td>
<td>61</td>
<td>0.97</td>
</tr>
<tr>
<td>Group B: info only</td>
<td>-0.68</td>
<td>-0.58</td>
<td>0.20</td>
<td>18</td>
<td>0.84</td>
</tr>
<tr>
<td>Group C: action only</td>
<td>5.18</td>
<td>1.40</td>
<td>-1.30</td>
<td>10</td>
<td>0.22</td>
</tr>
<tr>
<td>Pretest - Posttest Water Footprint Self-efficacy</td>
<td>M</td>
<td>Std. Err.</td>
<td>t</td>
<td>df</td>
<td>p</td>
</tr>
<tr>
<td>All students</td>
<td>1.03</td>
<td>-0.03</td>
<td>-1.82</td>
<td>91</td>
<td>0.07</td>
</tr>
<tr>
<td>Group A: info. and action</td>
<td>0.89</td>
<td>0.01</td>
<td>-1.37</td>
<td>61</td>
<td>0.18</td>
</tr>
<tr>
<td>Group B: info only</td>
<td>1.32</td>
<td>-0.34</td>
<td>-0.85</td>
<td>18</td>
<td>0.41</td>
</tr>
<tr>
<td>Group C: action only</td>
<td>1.36</td>
<td>0.23</td>
<td>-0.86</td>
<td>10</td>
<td>0.41</td>
</tr>
<tr>
<td>Pretest - Posttest Vegetarian Self-efficacy</td>
<td>M</td>
<td>Std. Err.</td>
<td>t</td>
<td>df</td>
<td>p</td>
</tr>
<tr>
<td>All students</td>
<td>-0.57</td>
<td>0.01</td>
<td>1.01</td>
<td>91</td>
<td>0.31</td>
</tr>
<tr>
<td>Group A: info. and action</td>
<td>-1.03</td>
<td>0.02</td>
<td>1.50</td>
<td>61</td>
<td>0.14</td>
</tr>
<tr>
<td>Group B: info only</td>
<td>0.42</td>
<td>-0.17</td>
<td>-0.35</td>
<td>18</td>
<td>0.73</td>
</tr>
<tr>
<td>Group C: action only</td>
<td>0.36</td>
<td>0.31</td>
<td>-0.22</td>
<td>10</td>
<td>0.83</td>
</tr>
<tr>
<td>Pretest - Posttest Communication Self-efficacy</td>
<td>M</td>
<td>Std. Err.</td>
<td>t</td>
<td>df</td>
<td>p</td>
</tr>
<tr>
<td>All students</td>
<td>-0.52</td>
<td>-0.04</td>
<td>0.85</td>
<td>91</td>
<td>0.40</td>
</tr>
<tr>
<td>Group A: info. and action</td>
<td>-0.45</td>
<td>-0.03</td>
<td>0.56</td>
<td>61</td>
<td>0.58</td>
</tr>
<tr>
<td>Group B: info only</td>
<td>-1.58</td>
<td>-0.04</td>
<td>0.98</td>
<td>18</td>
<td>0.34</td>
</tr>
<tr>
<td>Group C: action only</td>
<td>1.91</td>
<td>-0.44</td>
<td>-1.51</td>
<td>10</td>
<td>0.16</td>
</tr>
</tbody>
</table>
Significant Results

Over 400 paired t-tests were generated from the 14 individual self-efficacy questions parsed out by group (3+ all), gender (2), and level of prior commitment (7). Some significant results were discovered in this analysis, but these are not believed to be experimentally or practically relevant.

One such significant result was that low prior commitment students showed an increase in their self-efficacy with respect to reducing their emissions footprint a moderate amount after the competition (M = 7.18, SD = 2.00) compared to before the competition (M = 6.73, SD = 1.90), t(68) = -2.0, p = .04. These students did not show a significant increase in self-efficacy with respect to reducing their emissions footprint a large amount or a small amount after the competition compared to before the competition. The significant result was not found if the prior-commitment cutoffs was set at 0,2,4,6,8, or 10 instead of 7. It does not seem reasonable to accept that a prior commitment score of exactly 7 or lower is important and that engagement scores of 6 or 8 and lower are not when there is an alternative explanation for the significance found.

If we performed the same number of paired t-tests as were performed in this experiment (400+) but performed them on random data, we would still expect to see a ‘significant’ relationship from 20 or more of these (p = .05). These results would suggest an underlying mechanism or linkage where we know that the random data has none. The same logic applies to the multiple t-tests performed on this experiment’s data and is recognized as a statistical artifact -- ‘p-hacking’. This is well known in science where it can affect the reporting of results unwittingly and may also occur deliberately (Head et al., 2015).
In all the cases of a significant relationship in the experimental data there is no apparent mechanism supporting the relationship, beyond the likelihood of p-hacking. All significant results either fail the reasonableness test as outlined above or are mutually contradictory. It is therefore held that the experiment does not reject the null hypothesis with respect to self-efficacy as measured, and that a repeat of the experiment would not find significant results in the same areas as in this experiment.
Chapter IV
Discussion

Neither of the two areas researched: engagement with the climate crisis and self-efficacy showed an important result. The results and what they might mean is discussed below.

Engagement with the Climate Crisis

The experimental cohort showed a strong understanding that global warming is happening. As questions were not asked outside of the SaveOhno competition it is not known whether this was a result of self-selection of knowledgeable students by the competitors, or whether this reflects the opinions of Brandeis University as a whole. No significant change was seen in this understanding pretest to posttest.

The small drop in the proportion believing that the causes of global warming were mostly human were seen only in the two Groups taking action. This is the opposite result from that hypothesized. In the low prior commitment cohort a small drop was also seen but in all three Groups. This result could be investigated further, though the connection between this response and simple physical actions would be difficult to explain. If the result held up to further scrutiny it would advise against the use of simple physical actions in shifting understanding of the cause of global warming.

In the “harm” questions the larger positive effect in response to “When do you think global warming will start to harm people in the United States?” for the low prior commitment cohort may reflects a lower initial belief in current harm compared to the
full cohort. There was also a positive change in response to “How much do you think global warming will harm you personally?” It is possible that the increased understanding or other effect from participating in SaveOhno was behind these changes, but the size of the effects and their uneven nature across the different Groups suggests these results should be treated with caution.

In the emotional response questions, two results deserve consideration. First, the full cohort showed an increase in hopefulness or, expressed as a double negative, a reduction in levels of hopelessness. This would be consistent with the idea that greater power and understanding from participation could lead to improved hope. But, in the full cohort and the low prior commitment cohort the greatest change was seen in Group B, undermining Hypothesis 1A. Second, the full cohort showed an increase in “interest” in global warming, especially in the low prior commitment group. The mean and mode of this cohort’s responses both shifted from “Moderately interested” pretest to “Very interested” posttest, whereas the mode and median responses for the full cohort were “Very interested” both pretest and posttest. These results may justify further investigation as an effect was seen in one cohort, but they do not support Hypothesis 1A.

No significant result was seen in response to the students’ belief in their “personal impact”. This question is from YPCCC and was included in case a comparison to national data became useful. The same fundamental belief was pursued with more rigor in the section on self-efficacy.

Self-Efficacy

The research did not show a link between taking simple physical actions and a change in climate self-efficacy. Analysis of multiple dimensions, individual questions,
and different prior commitment cohorts only showed significant results where these were plausible discounted.

This lack of finding can be for two main reasons; either there is no link between taking simple physical actions and a change in climate self-efficacy, or there is a link but this experiment did not reveal it.

Existence of a Link Between Simple Physical Actions and Mental State

This section reviews how many links between physical intervention and mental state -- also recognized as the mind-body connection -- have been proven over the last 100+ years.

Ever since Pavlov and Skinner first researched operant conditioning (Pavlov, 1927; Skinner, 1932) we have understood that external stimuli can produce behavioral and also involuntary physical responses in animals and in humans. The stimuli were very different, ranging from a ringing bell to electric shocks, but this research showed long ago that external interventions can affect mental state and behavior.

Habit formation has also been found to be susceptible to external influences (Lally et al., 2010) even though it is difficult to experimentally induce habits in healthy humans (de Wit et al., 2018).

Active Learning, defined as "anything that involves students in doing things and thinking about the things they are doing" (Bonwell & Eison, 1991, p. 2), has been found to be effective at increasing learning and understanding. A meta-analysis of 225 active learning studies indicated that on average, student performance on examinations and concept inventories increased by 0.47 SDs (n=158 studies) and average examination scores improved by 6% (Mazur-Stommen & Farley, n.d.). The range of techniques
employed under the umbrella term of Active Learning are typically grouped into five areas (Duke University, n.d.). The last of these includes taking deliberate actions to cement uptake (Prince, 2004):

1. Think-Pair-Share: students think and write about questions, then pair with a partner to discuss their responses, followed by reporting out to the class.
2. One Minute Paper: students are asked to identify the clearest, or least clear points from the interaction, to be addressed at a later date.
3. Peer Instruction: having considered a question, students pair up and try to convince each other that their answer is correct.
4. Group Work: a structured cooperative learning activity that relies on individual accountability to reach group goals.
5. Case Studies and Practical Activity: Students discuss case studies or implement course content in the real world.

All of these disciplines support one of the fundamental assumptions behind the experiment, that some form of physical intervention is able to alter a subject’s mental state. As will be discussed below, a post-experiment literature review suggests that the strength of intervention in the experiment may have been insufficient to create a measurable impact.

Experimental Design and Execution

Weaknesses in the design and execution of the experiment may have resulted in a lack of findings. The areas of potential weakness are grouped into deficiencies in six areas:

- Use of a control
- Size and makeup of populations
- Number and duration of interventions
- Inclusion of multiple sustainability dimensions and non-action challenges
- Use of gamification
• Self-efficacy scale

Use of a Pure Control

Group B, which experienced only information and no other requirement of the students, did control for the taking of physical actions but no survey was done of students experiencing no intervention at all (Figure 12). Such a control may have revealed a background shift in attitudes and awareness over the three weeks that affect the entire population. This might be due to external effects that influence all participants, including news stories about climate and the environment, unusually hot or cold weather which are known to impact climate opinions (Konisky et al., 2016; Egan & Mullin, 2012; Joireman et al., 2010), or just the students’ calendar and workload. If a control group had shown a drop in levels of engagement, we might have determined that the lack of effect within the experimental cohort was significant.

Size and Makeup of Populations

Without knowing the strength of the possible effect being researched we cannot estimate the size of the population required to detect it. Less rigorous research on earlier data from SaveOhno suggested that a cohort of over 20 would show a baseline shift in attitudes, and a cohort of 100 should be sufficient to reveal differential movement between subgroups. However, this was not proven in this experiment. A larger cohort may find a significant self-efficacy result, but it is unlikely to be important. The shift in mean self-efficacy was less than 2% in all analyses. An effect of this size is not powerful enough to change the direction of climate engagement of the public.
We know that the population was not representative of the US by age, gender, and educational status. Furthermore, there may have been significant self-selection bias in those signing up for SaveOhno. One indication is the extent that participants’ responses differed significantly from national data.

Number and Duration of Interventions

The interventions in the game may not have been powerful enough to achieve the changes in attitudes and awareness sought. The game ran for three weeks and 10 actions requiring simple physical action, of which the median participant completed nine. In the other behavioral disciplines discussed at the start of this section, the relevant stimuli were more numerous and/or repeated and/or active over a longer duration.

Operant conditioning schedules of reinforcement typically include dozens or hundreds of repetitions (Ferster & Skinner, 1957). Habit forming has also been shown to require many iterations. In one habit forming experiment participants took a mean of 66 iterations to reach their peak ‘automaticity’ (Lally et al., 2010). Active Learning is also typically implemented with multiple interventions (Prince, 2004) over a much longer period than the experiment, with a whole semester as a typical duration (Van Amburgh et al., 2007).

One further indication of required intervention frequency can be found in habituation research. Habituation is “a form of non-associative learning in which a response to a stimulus decreases after repeated or prolonged presentations of that stimulus” (Bouton, 2007). This research was investigating whether a positive increase in self-efficacy and other engagement factors could be generated through simple physical actions. This approach can be considered as the equivalent of habituation to a negative
stimulus. Instead of framing the desired change as a positive increase self-efficacy we can frame it as a reduction in the influences preventing that self-efficacy. This then becomes an habituation to the negative elements of prosocial climate action, whatever those might be. We saw from our surveys that the students have knowledge and understanding of the climate crisis but are not acting congruently with that knowledge, as has been found elsewhere (Gifford et al., 2018; Lacroix & Gifford, 2018; Landry et al., 2018). There must therefore be some factor(s) that are preventing the congruent behavior. With the researched intervention we might repeat an action until the resistance to it becomes habituated.

As with the other disciplines discussed, habituation research indicates that there is a link between behavior and mental state, and that changes in both of these requires extended interventions (Rankin et al., 2009). We should therefore expect to find some effect, either positive or negative, after enough iterations.

A further factor is the level of intention. In the habit-forming research referenced above the participants were trying to create a new habit. In this experiment we were trying to induce an effect particularly on those that were previously uncommitted to the issue at hand.

Without a known frequency or duration to reveal an effect, if one exists with this experimental intervention, it is a reasonable starting point to assume that the strength of intervention in the other discussed disciplines might be similar to the strength of influence in the SaveOhno intervention. If this is true, then the number of actions a student would need to take was too low by a factor of between two and 20. If we factor in
the lack of intention on behalf of the target population we might increase these factors further.

The three-week duration of the competition was chosen because it was popular with students and is shorter than interventions in the parallel disciplines above as we have seen. If this duration was retained it could be a confounding factor for the effect desired.

Inclusion of Multiple Sustainability Dimensions and Non-Action Challenges

The game and the self-efficacy scale cover overlapping aspects of climate and sustainability, including diet, recycling activity, and energy use. This range set of concerns and actions was thought to have been additive – providing influences affecting multiple distinct factors in attitude change. The alternative was a single repeated dimension potentially susceptible to habituation. However, the range of actions may have not been strongly associated with each other or with the dimensions measured in the survey.

The SaveOhno competition included 17 challenges of which only 10 had an associated simple physical action. The seven non-physical challenges included calculation of the participant’s carbon footprint, subscribing to a sustainability newsletter, joining a “Buy Nothing” Facebook Groups and similar activities. These activities may have had an effect on the participants and their participation in them was not analyzed. A future implementation may exclude these elements to better isolate the impact of the simple physical actions.
Use of Gamification

Behavior change was achieved through gamification with the advantage that this approach attracted those not already motivated to participate in a sustainability exercise spanning weeks. Gamification had been shown to be very effective in behavior modification and the experiment it was successful in inducing participants to do things they stated they would not normally do, whether we detect an impact of that in our measures or not.

However, the use of gamification itself may have reduced the effect of the actions taken. By making the process a game it is possible that the messages delivered as well as the actions were put into a different context and their power reduced. These are the potentially counterproductive impacts of gamification on motivation (Diefenbach & Müßig, 2019).

Details of the implementation may also have had an unknown effect. Even small design changes in an implementation can have “huge impacts on the experience of players” (Rapp et al., 2019). Results from this research cannot therefore be assumed to apply to all uses of gamification in climate communication.

Self-Efficacy Scale

Self-efficacy scales have been developed and used in dozens, and maybe hundreds of different fields (Bandura, 1986) and there is no reason to believe that a self-efficacy scale for climate action should not also be possible. However, the scale developed and used in this research may not have been reliable as implemented. A pre-competition test of the scale did show differentiation between individuals, but this was
not linked with independent measures such as interviews or confirmed with test/re-test measures after an interval.

The research used self-efficacy as an indicator of impact on the individual and there may be a better measure of this. Further research might investigate whether future behavior did in fact change. There was no attempt to establish whether the self-efficacy score obtained related to actual engagement with the climate crisis for that individual, and this would be a useful improvement to this research approach.

Questions for Further Research

We know from operant conditioning, Active Learning, habit forming, and other elective change programs that behavior can be changed through internal and external intervention. Our question is whether targeted interventions, such as games can be used to make fundamental shifts in internal attitude and disposition.

Research to investigate this area further should consider the limitations in this experiment discussed above, particularly the number, degree, and duration of the interventions employed. Interventions might also be focused on a single dimension, such as energy usage, water footprint, or vegetarianism, for example.

A satisfactory metric has still not been proven, and research on building a reliable self-efficacy scale for climate crisis would be a valuable component of further research.

Conclusions

Cognitive theory suggests that directly changing an individual’s behavior could affect their internal mental state. Such an intervention would represent an additional mode of influence to the more usual use of 1) rational and emotional appeals to the
individual’s System 2 and System 1, respectively, and 2) nudging and related approaches that alter the environment in which a behavior takes place.

The intervention studied used a gamification platform to create a behavior change but as implemented there was no discernible impact on individual’s levels of engagement and self-efficacy with respect to global warming. Whether subjects experienced a simple physical action or not did not affect the results. Those with a low prior commitment to climate were thought to be more susceptible to this intervention but this was not found.

Review of the disciplines of operant conditioning, habit formation, and Active Learning suggests that the taking of physical action can have a measurable effect on the individual’s disposition and mental state. The lack of finding in this experiment suggests a deficiency in execution (use of control, size of cohort, validity of measurement tool, use of gamification), or in design. The parallel disciplines mentioned above indicate that the number of interventions performed may need to be increased by a factor of at least two and more likely 10 or higher. Future researchers may wish to adjust the factors discussed to better determine if behavior modification through gamification (or other means) is an effective mode of influence or not.

Should this mode of influence exist it does offer the possibility of adding to the suite of existing interventions in climate communications, wider sustainability areas, and potentially other prosocial areas such as increasing literacy and social justice.
Appendix 1
Survey Instrument

Table 9. Demographic survey questions.

<table>
<thead>
<tr>
<th>Question</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRODUCTION: There are no 'right' or 'wrong' answers to this survey, we just want to understand more about your opinions and understanding. You will earn maximum points for completing all questions, and no points for an incomplete response. The survey takes less than 5 minutes.</td>
<td></td>
</tr>
<tr>
<td>What is your age?</td>
<td>Under 18 / 18-24 / 25-34 / 35-44 / 45-54 / 55+</td>
</tr>
<tr>
<td>[If under 18 the survey did not allow the participant to continue]</td>
<td></td>
</tr>
<tr>
<td>What is your FULL .edu email address?</td>
<td>[free text]</td>
</tr>
<tr>
<td>If you are a student, what degree are you studying for? (optional)</td>
<td>● Undergrad /</td>
</tr>
<tr>
<td></td>
<td>● Masters</td>
</tr>
<tr>
<td></td>
<td>● Doctorate, PhD</td>
</tr>
<tr>
<td></td>
<td>● Certificate or other</td>
</tr>
<tr>
<td>If you are studying for a degree, when is your anticipated graduation? (optional)</td>
<td>2021 / 2022 / 2023 / 2024 / 2025+</td>
</tr>
<tr>
<td>If you are a student - what is your major/ field of study? (optional)</td>
<td>[free text]</td>
</tr>
<tr>
<td>How do you identify your gender?</td>
<td>Female, Male, Non-binary, Prefer not to say, Transgender, Cisgender, Agender Genderqueer, A gender not listed, Other…</td>
</tr>
</tbody>
</table>
Table 10. Past activity survey questions.

INTRODUCTION: A set of questions about how involved you have been in climate and other environmental action.

<table>
<thead>
<tr>
<th>Question</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have you ever attended a voluntary (extra-curricular) movie, talk or seminar, panel or workshop on climate change or the environment?</td>
<td>Y/N</td>
</tr>
<tr>
<td>Have you written a letter or email to a newspaper, or local, state or national representative on the subject of climate change or the environment?</td>
<td>Y/N</td>
</tr>
<tr>
<td>Have you ever volunteered for an environmental organization?</td>
<td>Y/N</td>
</tr>
<tr>
<td>Have you been on an environmental march or demonstration?</td>
<td>Y/N</td>
</tr>
<tr>
<td>Which of the following actions have you performed because of your desire to reduce your personal carbon footprint? (check all that apply, including if emissions reduction was not your only motivation)</td>
<td>Y/N</td>
</tr>
<tr>
<td>• Turned off lights</td>
<td></td>
</tr>
<tr>
<td>• Used public transport</td>
<td></td>
</tr>
<tr>
<td>• Adjusted thermostat down in winter or up in summer</td>
<td></td>
</tr>
<tr>
<td>• Closed doors or windows</td>
<td></td>
</tr>
<tr>
<td>• Reduced meat consumption</td>
<td></td>
</tr>
<tr>
<td>• Unplugged or switched off electronics</td>
<td></td>
</tr>
<tr>
<td>• Other…</td>
<td></td>
</tr>
<tr>
<td>Have you ever calculated your carbon footprint?</td>
<td>Y/N</td>
</tr>
</tbody>
</table>
Table 11. Attitude and awareness survey questions.

**INTRODUCTION:** A set of questions about your views on global warming. Global warming refers to the idea that the world’s average temperature has been increasing over the past 150 years, may be increasing more in the future, and that the world’s climate may change as a result.

<table>
<thead>
<tr>
<th>Question</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you think that global warming is happening?</td>
<td>Y/N</td>
</tr>
</tbody>
</table>
| Assuming global warming is happening, do you think it is… | • Caused mostly by human activities  
• Caused mostly by natural changes in the environment  
• Neither because global warming isn’t happening  
• Caused by human activities and natural changes  
• Don't know |
| How strongly do you feel each of the following emotions when you think about the issue of global warming? Worried / Interested / Helpless / Hopeful | • Very  
• Moderately  
• Not very  
• Not at all |
| When do you think global warming will start to harm people in the United States? | They are being harmed right now / In 10 / 25 / 50 / 100 years / Never |
| How much do you think global warming will harm you personally? | • A great deal  
• A moderate amount  
• Only a little  
• Not at all  
• Don't know |
| Which of the following statements comes closest to your view? | • Humans can reduce global warming, and we are going to do so successfully  
• Humans could reduce global warming, but it’s unclear at this point whether we will do what’s needed  
• Humans could reduce global warming, but people aren’t willing to change their behavior, so we’re not going to  
• Humans can’t reduce global warming, even if it is happening  
• Global warming isn’t happening |
| How much impact can you personally have in the fight against climate change? (check ‘0’ if you believe no impact is required) | 0 - 10 |
INTRODUCTION: A set of questions about the science of global warming. There are no extra points for answering these questions 'correctly', please answer according to your current understanding. Greenhouse gasses are those that trap heat in the earth's atmosphere and contribute to global warming.

<table>
<thead>
<tr>
<th>Question</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Which of the following are greenhouse gases (check all that apply)</td>
<td>• Carbon dioxide</td>
</tr>
<tr>
<td></td>
<td>• Methane</td>
</tr>
<tr>
<td></td>
<td>• CFCs, HCFCs</td>
</tr>
<tr>
<td></td>
<td>• Water vapor</td>
</tr>
<tr>
<td></td>
<td>• Ozone</td>
</tr>
<tr>
<td></td>
<td>• None of the above</td>
</tr>
<tr>
<td>The carbon footprint/ greenhouse gas emissions of the average American is how many times the global average?</td>
<td>• 6-10 x</td>
</tr>
<tr>
<td></td>
<td>• 3-5 x</td>
</tr>
<tr>
<td></td>
<td>• 2 x</td>
</tr>
<tr>
<td></td>
<td>• The same as the global average</td>
</tr>
<tr>
<td></td>
<td>• 0.5 x</td>
</tr>
<tr>
<td></td>
<td>• 0.1 x</td>
</tr>
<tr>
<td></td>
<td>• I don't know</td>
</tr>
<tr>
<td>Most scientists believe what total amount of warming over historical temperatures is the limit before catastrophic effects become likely?</td>
<td>• 0.0 degrees C (0.0 F)</td>
</tr>
<tr>
<td></td>
<td>• 0.75 degrees C (1.4F)</td>
</tr>
<tr>
<td></td>
<td>• 1.5 degrees C (2.7F)</td>
</tr>
<tr>
<td></td>
<td>• 2 degrees C (3.6F)</td>
</tr>
<tr>
<td></td>
<td>• 3 degrees C (5.4F)</td>
</tr>
<tr>
<td></td>
<td>• 5 degrees C (9.0F)</td>
</tr>
<tr>
<td></td>
<td>• 10+ degrees C (18.0+ F)</td>
</tr>
<tr>
<td>Most scientists believe the world needs to reduce greenhouse gas emissions by what proportion by 2050 to stay within the catastrophic temperature limit?</td>
<td>• 0 - 20%</td>
</tr>
<tr>
<td></td>
<td>• 20 - 40%</td>
</tr>
<tr>
<td></td>
<td>• 40 - 60%</td>
</tr>
<tr>
<td></td>
<td>• 60 - 80%</td>
</tr>
<tr>
<td></td>
<td>• 80 - 100%</td>
</tr>
</tbody>
</table>
Table 13. Self-efficacy practice question.

INTRODUCTION: This section asks questions about your current ability to take certain steps to reduce the effects of climate change. To familiarize yourself with the rating form, please complete this practice item first.

<table>
<thead>
<tr>
<th>Question</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>If you were asked to lift objects of different weights right now, how certain are you that you can lift each of the weights described below?</td>
<td></td>
</tr>
<tr>
<td>Rate your degree of confidence by recording a number from 0 to 10 using the scale given below.</td>
<td></td>
</tr>
<tr>
<td>• Able to lift a 10 pound/ 4kg weight</td>
<td></td>
</tr>
<tr>
<td>• Able to lift a 50 pound/ 8kg weight</td>
<td></td>
</tr>
<tr>
<td>• Able to lift a 100 pound/ 40kg weight</td>
<td></td>
</tr>
<tr>
<td>• Able to lift a 250 pound/ 100kg weight</td>
<td></td>
</tr>
<tr>
<td>0 Cannot do at all</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5 Moderately can do</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
</tr>
<tr>
<td>10 Highly certain can do</td>
<td></td>
</tr>
</tbody>
</table>
Table 14. Self-efficacy survey questions.

<table>
<thead>
<tr>
<th>Climate Footprint</th>
<th>People sometimes do things to reduce the climate/ greenhouse gas/ carbon emissions that they are responsible for. This is referred to as their 'climate footprint'. Please rate how certain you are that you can do the following things:</th>
</tr>
</thead>
</table>
|                   | • Able to reduce your carbon footprint by a small amount  
|                   | • Able to reduce your carbon footprint by a moderate amount  
|                   | • Able to reduce your carbon footprint by a large amount  | 0 – 10 presented as in the example question |

<table>
<thead>
<tr>
<th>Water Footprint</th>
<th>Water is consumed in bathing, cooking, growing food, making products and energy, and other activities. This is referred to as your 'water footprint'. Please rate how certain you are that you can do the following things:</th>
</tr>
</thead>
</table>
|                  | • Able to reduce your water usage by a small amount  
|                  | • Able to reduce your water usage by a moderate amount  
|                  | • Able to reduce your water usage by a large amount  | 0 – 10 presented as in the example question |

<table>
<thead>
<tr>
<th>Eating Vegetarian</th>
<th>Please rate how certain you are that you can do the following things:</th>
</tr>
</thead>
</table>
|                   | • Able to eat vegetarian meals occasionally  
|                   | • Able to eat vegetarian meals often  
|                   | • Able to eat vegetarian meals most of the time  
|                   | • Able to eat vegetarian meals all of the time  | 0 – 10 presented as in the example question |

<table>
<thead>
<tr>
<th>Talking about climate change</th>
<th>Please rate how certain you are that you can do the following things:</th>
</tr>
</thead>
</table>
|                              | • Able to talk to family about climate change  
|                              | • Able to talk to friends about climate change  
|                              | • Able to talk to strangers about climate change  
|                              | • Able to talk to people in positions of authority, such as politicians, journalists, and business leaders, about climate change | 0 – 10 presented as in the example question |
Table 15. Consent survey questions.

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Will you help us with research into the effectiveness of the SaveOhno program?</td>
<td>We believe that the SaveOhno program increases students’ understanding of sustainability and this year, research is being conducted by SaveOhno’s CEO, Quentin Prideaux, on the impact of the program. You are asked to complete a &lt;10 minute survey before and after the competition, and if you consent then your responses can be part of the research. All participants in SaveOhno will be randomly assigned to one of two groups: those that are asked to take physical actions in the program, and those that are not. Every team will have the same proportion of the two groups. We do hope that you agree to letting your survey responses be used in the research to help us understand the impact of SaveOhno. Participation is optional, you can withdraw from the research at any time, and consent does not affect your ability to be in the SaveOhno program. The detailed consent form follows.</td>
</tr>
<tr>
<td>Many thanks indeed Quentin Prideaux <a href="mailto:qprideaux@g.harvard.edu">qprideaux@g.harvard.edu</a></td>
<td></td>
</tr>
</tbody>
</table>

Quentin Prideaux
qprideaux@g.harvard.edu

Research Participation Consent

Please read this information and then indicate whether you do/ do not consent to your survey data being used in this research project.

Study Title: The Gamification of Climate Action
Researcher: Quentin Prideaux
Faculty Advisor: Dr Mark Leighton

The following is a short summary of this study to help you decide whether or not to be a part of this study. More detailed information is listed below.

Why am I being invited to take part in a research study?
We invite you to take part in a research study because you are participating in the Brandeis SaveOhno program.

What should I know about a research study?
• Someone will be available to explain this research study to you.
• Whether or not you take part is up to you.
• Your participation is completely voluntary.
• You can choose not to take part.
• You can agree to take part and later change your mind.
• Your decision will not be held against you.
• Your refusal to participate will not result in any consequences or any loss of benefits that you are otherwise entitled to receive.
• You can ask all the questions you want before you decide.

Why is this research being done?
The purpose of the research is to investigate the degree to which taking physical action increases a student’s level of perceived power over the climate crisis.

How long will the research last and what will I need to do?
The research consists of two surveys – one before and one after the program. These surveys ask about your knowledge of, disposition toward, and engagement with global warming. The surveys are estimated to take less than 10 minutes each.

Is there any way being in this study could be bad for me?
We don’t believe there are any risks from participating in this research.

Will being in this study help me in any way?
There are no benefits to you from your taking part in this research. We cannot promise any benefits to others from your taking part in this research. However, possible benefits to others include an increased understanding of how to positively affect levels of engagement with the climate crisis and other environmental programs.

Detailed Information
The following is further detail about this study in addition to the information listed above.

What is the purpose of this research?
Many different forms of communication have been used to inform and engage members of the general public with the climate crisis. These methods have been effective in increasing understanding of climate change, but less effective at prompting behavior change. It is theorized that by engaging people physically with actions appropriate to improving climate and reducing emissions they will feel more empowered to act. The study assesses the level of participants’ self-efficacy (belief in their own power and influence) and degree of commitment to action.

How long will I take part in this research?
If you agree to be part of this study you will go through the normal SaveOhno program but will receive two surveys. One in the beginning of the program and one after. The surveys will take fewer than 10 minutes.

What can I expect if I take part in this research?
You will be asked to take part in two surveys, one in the beginning of this program and one after. Sample survey questions include:
- How worried are you about global warming?
- When do you think global warming will start to harm people in the United States?
You may be invited to participate in a further study after an interval of three months or more by responding to further survey questions. Your participation at that time, as with this research is completely voluntary and you may refuse to participate at any time.

What happens if I say yes, but I change my mind later?
You can leave the research at any time; it will not be held against you.

If I take part in this research, how will my privacy be protected? What happens to the information you collect?
We will collect your email address, name, age, and your responses to survey questions on the subject of the environment and your disposition toward the climate crisis. This Personal Information will be kept on a password-protected website and will be anonymized before use in the study.

Efforts will be made to limit the use and disclosure of your Personal Information, including research study and medical records, to people who have a need to review this information. We cannot promise complete secrecy. Organizations that may inspect and copy your information include the IRB and other representatives of this organization.

Your information or samples that are collected as part of this research will not be used or distributed for future research studies, even if all of your identifiers are removed.

Researcher Financial Interests in this Study
Quentin Prideaux, a researcher on the study team, is the CEO and minority shareholder of SaveOhno, the company running the program on which this research is based. This disclosure is made so that you may determine whether this relationship affect your willingness to participate in this study. If you have questions, please inform the study coordinator, and s/he will put you in touch with someone to talk to.

Who can I talk to?
If you have questions, concerns, or complaints, or think the research has hurt you, talk to the research team at quentin@saveohno.org, 508-353-6964
This research has been reviewed and approved by the Harvard University Area Institutional Review Board (“IRB”). You may talk to them at (617) 496-2847 or cuhs@harvard.edu if:
• Your questions, concerns, or complaints are not being answered by the research
team.
• You cannot reach the research team.
• You want to talk to someone besides the research team.
• You have questions about your rights as a research subject.
• You want to get information or provide input about this research.

Thank you

You will have an opportunity to withdraw your consent after you have finished the survey. I have read the consent details and

• I do not consent to my survey data being included in this research study.
• I do consent to my survey data being included in this research study.

Table 16. Physical challenges.

<table>
<thead>
<tr>
<th>Unplugging or turning off</th>
</tr>
</thead>
<tbody>
<tr>
<td>Almost everything plugged in uses power even when it's &quot;off&quot;. And burning lights in an empty room - that's just crazy. Coal is mined, transported, burned, turned into greenhouse gasses, soot, mercury, and other pollution. Lives are risked, mountains are ruined, and gas is fracked to generate electricity. All to light a room you're not in, or power a device you're not using?? That's nuts. And it definitely doesn't SaveOhno. Switching off a device isn't usually enough, a cable box uses almost as much energy when it is &quot;off&quot;. We know you can turn it right back on again, so you don't get a LOT of points for this one. But if you turn off the lights whenever you leave a room, you can reduce greenhouse gas emissions by 0.15 pounds per hour! This is a small action to change in your daily life that really adds up over time.</td>
</tr>
</tbody>
</table>

To get your points, share a selfie of you turning off or unplugging a device.

<table>
<thead>
<tr>
<th>Plants 4 the win</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experts agree that eating less meat and dairy products is vital to slow down climate change. The global livestock industry produces more greenhouse gas emissions than all cars, planes, trains, and ships combined! A report from the Intergovernmental Panel on Climate Change found that dietary change can “substantially lower” greenhouse gas emissions. Simply make your lunch or dinner meat-free and post a picture of you AND your meal - and it needs to be an actual meal, not a picture of a granola bar!</td>
</tr>
</tbody>
</table>

To get your points, share a selfie of you with your meat-free meal.

<table>
<thead>
<tr>
<th>Clothes like it cold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Washing with cold water is just as effective as washing with hot water, and saves loads(ha) of energy, money and emissions! Old detergents only worked in hot water, later they were still formulated for hot water because that's what everyone was used to using. Now that's all over. Machines and detergents are both made to work Just as well with cold water. So it's time to switch to a cold-cold wash if you haven't already. As a bonus your clothes will last longer and keep their color!</td>
</tr>
</tbody>
</table>

To get your points, share a selfie of you with a washing machine set on cold.

<table>
<thead>
<tr>
<th>Recycle where you are</th>
</tr>
</thead>
<tbody>
<tr>
<td>You can't throw anything &quot;away&quot; because there is no place called &quot;away&quot;. Instead, your trash is driven dozens or hundreds of miles in a huge truck and then thrown on the ground. It's called landfill. So, it's helpful to set up your own recycling bin in your room or home if you don't already have one. Fancy or plain, a used box, a bag or other container, anything that works. When your bin is full you can take it to a local recycling center, library, supermarket, town facility, etc. 1,000 bonus points at the end of the competition for the team with the most creative recycling bin!</td>
</tr>
</tbody>
</table>

75
To get your points, share a selfie of you with your room recycling bin.

No to disposable tableware

Many are aware of single-use plastic straws and the pointlessness of the damage they do. Plastic 'silverware' takes dirty oil out of the ground, uses energy to turn it into plastic, is unpleasant, used once, and then thrown in landfill for thousands of years. It's super easy to bring your own utensils - metal, bamboo - to a dining hall (or wherever you may eat)!

To get your points share a selfie of you dining with your reusable silverware!

Shorter showers save water

An average shower uses about 5 gallons of water per minute! If you shorten your shower by just 2 minutes, you can cut your water use by 10 gallons. And some of you could shorten your shower by 30 minutes at least....Water is one of our most precious resources on Earth, and less than one percent of it is available for bathing and drinking! Lowering your water usage diverts less water from our rivers, bays, and estuaries and decreases energy needed to pump and process it, also helping air pollution and climate.

To get your points pledge to take a shorter shower next time!

A forest bath revives

Public open space is so important to human and ecological health. They are places where people gather to have a sense of community and ownership, and that improve air quality, treat storm water, reduce heat islands, and provide habitat for wildlife.

To get your points upload a picture of yourself enjoying a public green space outside. You can be doing any activity like exercising, studying, socializing with friends, playing a game, or just relaxing.

Erase the Food Waste

Brandeis students waste an average of *200lb* of food per year each! Food farmed, prepared, and shipped without being eaten is a 100% waste of every step of that process. Uneaten food sent to landfill emits methane - a gas 80x as powerful as carbon dioxide in global warming. Do your part to reduce waste by taking only what you need, and eating what's on your plate.

To get your points upload a selfie with your clean plate!

We mean it about the plants

Seriously, the carbon and water footprint of this one action dwarfs the others - the impact of eating meat is ENORMOUS. So do it again - eat a plant-based meal. Each pound of beef takes 10,000 gallons of water to reach maturity and slaughter. Carbon emissions are 2-3x a vegetarian meal.

To get your points make your lunch or dinner meat-free and post a picture of you AND your meal - and it needs to be an actual meal, not a picture of a granola bar!

Tree hugging works wonders

As we all know, acting to make a difference isn't nearly as powerful as *thinking* about acting. And with the power of trees that thinking will be transformed into reality! So - you know what you need to do - think really hard while hugging a tree! You will receive ONE SaveOhno point for signing up and ONE SaveOhno point for completion. And this will in no way help you win the competition. We do not want you to do this. It's silly. Thinking alone doesn't work. Acting works. (Of course, thinking AND acting doesn't hurt)

To get your single point upload picture of you hugging a tree.
Table 17. Non-physical challenges.

| **Brandeis 2021 Welcome Survey** |
| Tell us a little about yourself and your opinions on sustainability. This 7-minute survey earns you a bunch of points, so do complete it and make sure your team-mates complete it too. |

| **Social media** |
| Like Sustainable Brandeis on Facebook and follow them on Instagram to receive updates on environmental events, climate news, and helpful information about disposing of waste on campus! Take a screenshot showing your own name/ID! |

| **UCapture savings** |
| UCapture is a simple browser extension that gives you coupon codes while shopping online and also offsets your carbon footprint! It's important to only buy what you need, but when you do find yourself checking out online, with the click of a button you can help support an environmental project! The extension is completely free and even saves you money. UCapture partners with over 25,000 stores and collects commissions from them to fund verified carbon offset projects. Read more and download the extension at LINK |

| **Know your carbon footprint** |
| Knowledge is power. Find out how you're doing on carbon emissions by completing the survey here LINK. You don't have to include the "House" section as you may not have that information with you. Notice how big (and small) some effects are - 1,000 miles for a daily bus commute/ car/ one short plane ride for vacation, for example. Upload a screenshot of your results and see how high your "footprint" is compared to the country and where we need to get to. Then you can work on making it lower! |

| **Join Buy Nothing Brandeis!** |
| Many of today's environmental issues can be linked to a culture of pointless consumerism. The demand for goods is rapidly increasing leading to more pollutant emissions, greater land-use and deforestation, and accelerated climate change. Many items that consumers buy end up unused or in landfills and the oceans. To combat this culture of buying new, learn to reuse and give to others! Buy Nothing Brandeis is a Facebook group that allows you to pass on items to new homes after you no longer need them! The Buy Nothing Project offers people a way to give and receive, share, lend, and express gratitude through a worldwide network of gift economies in which the true wealth is the web of connections formed between people who are real-life neighbors. Join Buy Nothing Brandeis Facebook Group here LINK. If you are living off-campus this semester, you are welcome to join the group for your local area instead. Upload a screenshot of your membership - for Facebook this means the Buy Nothing Brandeis page showing your ID along with "Invite" (instead of "Join Group"), as in the example photo. Read more at Buy Nothing Project LINK |

| **Sign up for the Sustainable Brandeis newsletter!** |
| Sign up for the Sustainable Brandeis newsletter to get the latest news on Brandeis energy conservation, efforts to increase dining sustainability, the Climate Action Plan, and more! Sign up here LINK |

| **Climate Solutions Panel April 8** |
| Solve Climate by 2030 is an international movement to have important discussions regarding regional climate solutions, energy justice, and a Green Recovery to the climate crisis. Mary Fischer and James Ji of Brandeis are hosting this year's Massachusetts Solve Climate by 2030 webinar. This is a great opportunity to hear from knowledgeable speakers and learn about regional and local solutions to addressing climate change. Register for the April 8th webinar at this link! LINK |

| **Sustainability Violation Alert** |
| Peer reinforcement is a key part of maintaining a culture of sustainability. We have to call it out and make it OK to speak up when we see unsustainable behavior. Our future - and Ohno's - depends on it! Keep your eyes open for some unsustainable behavior, and then fill out and issue a violation using this ticket or equivalent: LINK Take a selfie of you and the person you are issuing the completed violation to. The person receiving your ticket NEEDS TO BE SMILING. So be NICE about it. They probably meant to do the right thing, but sometimes it's hard or we forget. No one is perfect. |

| **Thank You Survey** |
| Thank you SO much for taking part in SaveOhno! We hope you had fun, and maybe learned something also. Take the (4 minute) survey here LINK. PLEASE complete this survey - whether you think it will get you a prize or not, your attitudes are vital for the research being done on SaveOhno, and to helping make this even better in the future. |
Appendix 2

Participants’ Genders

Brandeis University reports a gender mix of 60% female students and 40% male (How does Brandeis University rank among America’s best colleges?, n.d.). The survey included more gender options and the volunteers for SaveOhno were 67% female or female non-binary, and 26% male. Other genders were too few for analysis. The full breakdown of genders is shown in Table 18

Comparisons by gender produced the same null result in all self-efficacy dimensions.

Table 18. Participant gender distribution.

<table>
<thead>
<tr>
<th>Group</th>
<th>Female</th>
<th>Male</th>
<th>Non-binary</th>
<th>Female, Non-binary</th>
<th>Non-binary, Transgender</th>
<th>Prefer not to say</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALL</td>
<td>65%</td>
<td>26%</td>
<td>3%</td>
<td>2%</td>
<td>2%</td>
<td>1%</td>
</tr>
<tr>
<td>A</td>
<td>63%</td>
<td>27%</td>
<td>2%</td>
<td>3%</td>
<td>3%</td>
<td>2%</td>
</tr>
<tr>
<td>B</td>
<td>63%</td>
<td>26%</td>
<td>11%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>C</td>
<td>82%</td>
<td>18%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>
References


Climate change in the American mind. (2020, April). Yale Program on Climate Change Communication. Yale University and George Mason University. New Haven, CT.


Liu, P. R., & Ratery, A. E. (2021). Country-based rate of emissions reductions should increase by 80% beyond nationally determined contributions to meet the 2 °C target. *Communications Earth & Environment, 2*(1), 1–10. https://doi.org/10.1038/s43247-021-00097-8


https://doi.org/10.2139/ssrn.2924095


https://doi.org/10.1080/00221309.1932.9918467


United States. (1988). Greenhouse effect and global climate change: hearings before the committee on energy and natural resources, United States Senate, one hundredth Congress, first session. U.S. G.P.O. //catalog.hathitrust.org/Record/010021970


