Information Display for Societal Problems: Data, Game, or Choice?

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Abstract

The effects of climate change are costly and devastating but it is difficult to incentivize people to reduce their carbon footprint. E-Mission is designed to collect accurate data on a user's travel behavior and the corresponding footprint. Accurate data helps design intelligent climate change policy intervention. The usefulness of E-Mission depends on user engagement, but this is challenging because the consequences of climate change are not salient at a personal level. The study investigates three approaches grounded in behavioral economics to display results and measures their effect on user engagement. The first version displays a data heavy visualization of results, the second converts the results into a game, and the third allows a choice between the two. Among the 20 respondents, the 'choice' group had the lowest drop-off rate; this indicates that allowing users to choose their own visualization is more effective than choosing one for them.

Author Keywords

climate change; transportation; self-tracking app; app engagement

ACM Classification Keywords

Experimentation; behavioral economics; design

Introduction

Greenhouse gas (GHG) emissions contribute to global warming and climate change, causing costly and potentially devastating environmental and economic consequences. Passenger car emissions make up approximately $1/9^{th}$ of total GHG emissions in the

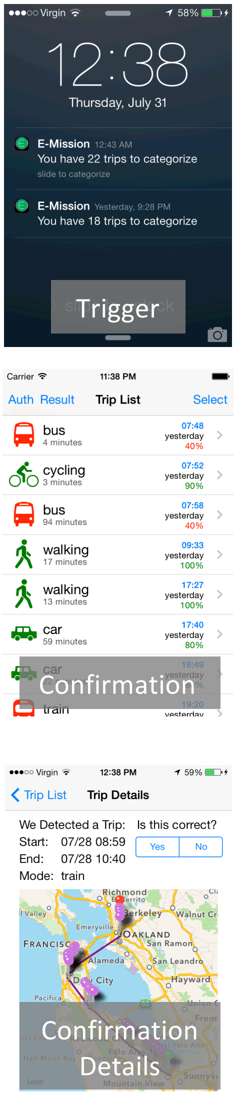

Figure 1. Trigger, Confirmation, and Results Screens

United States. [1]. In order to reduce transportation related emissions, alternative transportation modes (e.g. walking, biking, taking public transit) must be encouraged.

The challenge of climate change mitigation is that it requires collective action [2]. However adopting climate change mitigation practices is typically inconvenient and sometimes costly. For many car owners, driving is often more convenient and time-saving than taking public transit. Meanwhile climate change is a problem with globally-scoped consequences that are uncertain, long-range, and difficult to translate to a personal level. An individual's efforts do not result in tangible progress – the air around you does not become perceptively cleaner when you choose walking over driving.

This is a classic case of the tragedy of the commons which calls for intelligently designed policy to mitigate passenger car emissions, requiring accurate data on individual travel patterns. Prior efforts to collect this information have been stymied by low accuracies or reliance on supplementary devices [7, 8]. However, with smartphone usage so widespread now, we can build a system that achieves high accuracy by using prompted recall on the smartphone, and aggregates the information to help detect large scale patterns. E-Mission is a self-tracking mobile phone app that incorporates both these components.

Self-tracking apps like E-Mission are increasingly popular, but have difficulty acquiring long-term users because:

• Effort: Apps that require the user to record their habits require too much effort, and are quickly abandoned.

• Gain: If the user does not gain additional insight after an initial period of use, their reward may be insufficient to continue tracking.

E-Mission does not only aim to track user behavior, but also has an additional goal of aggregating information and using it as a source of societal scale data. This is even more challenging because:

• The only person who can correct the information to make it more accurate is the user, since she is the only one who knows how she really took the trip. This means that standard crowdsourcing techniques such as paying for Human Intelligence Tasks will not work.

• Even if the user does not gain additional insights, we still want users to continue engaging with the app because the societal level benefits continue.

In E-Mission, we currently use the following techniques to reduce effort and increase gain:

• Effort: We automatically, using GPS and accelerometer data, detect trips and predict modes. The user is able to confirm a set of these trips with a single click.

• Trigger: We generate notifications prompting users to confirm their trips.

• Gain: We provide users with an accounting of their carbon footprint. In this paper, we explore three

Figure 2. Result Screens for the Three Experimental Groups

techniques for providing their results to users and measuring the impact on user engagement.

App Design

The usefulness of E-Mission is dependent on the user's engagement with the app. In order for trips to be recorded, the user must confirm, once prompted, that her recorded trip is accurate. In order to understand the interfaces that can increase human engagement with this type of app, the participants were placed into three experimental groups:

1. Data visualization group
2. Gamification group
3. Choice group

Our goal for this study is to compare engagement rates between the three groups.

Data Visualization

The results screen for the data visualization group is information heavy and displays user's weekly carbon footprint calculation next to comparison metrics:

Average of other E-Mission users: This metric allows users to compare their footprint to the average footprint. If the user's score is higher than the average, she may feel compelled to change her behavior.

Goal setting metrics: We include two absolute goals extrapolated from the GHG emission reduction targets for California to help inform and incentivize individuals with lower than average emissions. These include both the relatively modest 2035 goal and the ambitious 2050 goal.

Best case and worst case scenario metrics: These scenario footprints are based on whether the user takes alternative transit only or drives only for all confirmed trips.

This view presents the information without value judgment. However, the components of the data visualization results screen do not address the question of whether people want to track their carbon footprint, which is an abstract concept that lacks personal relevance for most. On the other hand, it is unclear whether the numbers even need to have personal meaning for them to be useful by self-trackers. As Gary Wolf, a key proponent of the quantified self-tracking movement, points out, "For many self-trackers, the goal is unknown...[They] continue because they believe their numbers hold secrets that they can't afford to ignore, including answers to questions they have not yet thought to ask."[4]

Gamification

This view focuses on the user's emotional engagement with the app through a game that rewards users for engaging with the app (confirming trips at least daily) and using eco-friendly transportation. The gamification techniques include:

• Clear goals and rules: The results screen displays the rules as seen in Figure 3.

• Frequent feedback system: The user can progress through 15 stages, which means that there is frequent reminder of their progress.

• Manageable challenges: In order to avoid frustration, the point system is carefully designed so that it is not

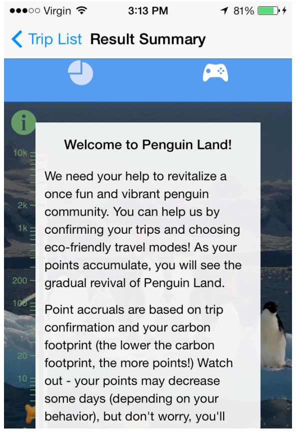

Figure 3. Game Rules

	Pros	Cons
Data	• Specific footprint numbers presented • Non-judgmental presentation	• Dry presentation of data • Uncertain whether data presented is of interest to the
Game	• Emotional involvement • Easy to understand (rules are not complicated and score bar is displayed on side of screen)	• Specific footprint numbers not presented • User does not know the specific formula for how points are calculated
Choice	• Incorporates preference matching • More novelty and sense of control	• Increased cognitive load

Table 1. Summary of Result Screen Characteristics

too difficult for users to accrue points. A manageable point scheme was devised by using a previous three-month history of E-Mission's existing users

• Make the stages harder: In order to provide an ongoing challenge, the difficulty of leveling up increases in later levels. A logarithmic scale determines when to move up a stage.

• Increasing novelty: The result image changes every time the user moves to a new stage.

• Voluntary engagement: The user can confirm their trips at any time, and can uninstall the app at any time if they want to discontinue tracking. [5] [6]

The difference between the data view and the game view is the imposition of a value judgment on travel patterns. In order to take a complicated concept such as the user travel patterns and convert it to a single, easily understandable score, we had to assign values to the various metrics depicted in the data view.

Choice

The choice option allows the user to switch between the data and game views at will. This allows them to get the benefits of both approaches, and also allows them to discover which option they prefer. People frequently don't know what information they need to make a decision, and behavioral responses to information are heterogeneous [3]. Allowing people to choose, and then making the choice "sticky" allows people to discover what information motivates them. But this choice increases their cognitive load. Therefore the choice screen can affect engagement in either direction

Survey Design and Recruitment

A survey taken prior to installation helps isolate the display effects on engagement. We hypothesize that the respondent is more likely to engage with the app if he is highly engaged with his smartphone, and views climate change as an important social problem:

• Engagement with Smartphone: the survey asks the respondent how often he uses social media apps on his phone and what his favorite phone apps and functions are. These questions provide a quantifiable proxy of how engaged the user is with his smartphone. For example, if the user were to state that an app that tracks personal habits is one of his favorite apps, he may exhibit higher engagement with E-Mission.

• Engagement with Climate Change: The survey presents the respondent with eight issues (climate change, poverty, etc.) and asks the respondent to pick the three that he cares most about.

Demographic questions provide further insight regarding respondent's potential engagement with apps on a smartphone. Number of small children, for instance, provides a proxy for how time constrained individuals are, which can explain low engagement. We ask geographic questions, along with questions about the individuals' travel behavior, for future research on whether the three different versions of the app are correlated with changes in travel behavior.

Recruitment occurred primarily on the UC Berkeley campus via e-mails and flyers that stated that participation includes a five-minute survey and app installation (the end of the survey led directly to the app installation page). In order to motivate participants to engage with the app, we entered participants in a raffle for three American Express cards valued at $25,

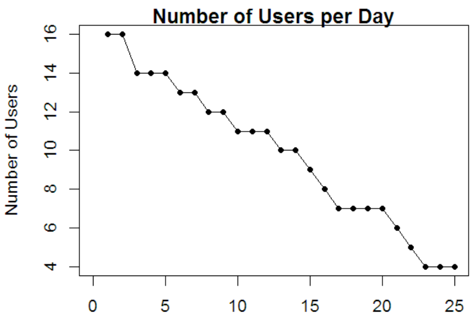

Figure 4. User Drop-Off

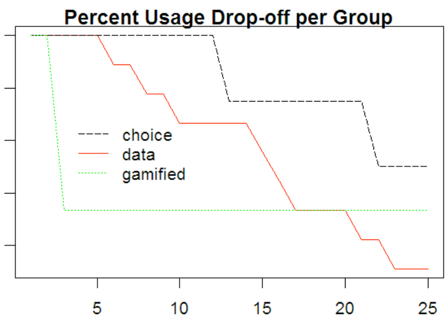

Figure 5. User Drop-Off per Group

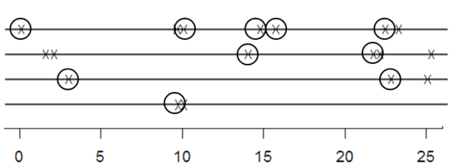

Figure 6. Results Switching Behavior

which they were eligible for if they completed the survey and engaged with the app for at least a week.

Results

Sixty-seven people took the survey. Twenty of them ended up installing the app, four of whom failed to use it. Of the remaining sixteen, Figure 4 shows that sixty-five percent of the participants used E-Mission for at least one week.

Usage patterns fell in largely one of three outcomes: the user either installed but did not use the app (inactive), used it for a couple days and then quit (semi-active), or engaged with E-Mission for the entire study window (active). The outcomes had a relatively even distribution of 35/45/25 percent.

Because of the high number of users who took the survey but did not download the app, groups were uneven: eleven users were assigned to “Data”, three to “Game”, and six to “Choice”. The drop-off rates were quite different among these three groups. As Figure 5 shows, only one of the three gamified users used the app, resulting in a low percentage. On the other hand, choice users had the lowest drop-off rate out of the three.

Figures 7-9 show sample behavior for inactive, semi-active, and active users with detailed engagement metrics: number of times users classified their trips per day, number of times users viewed their result screens, number of trips per day, percent confirmation, and carbon footprint score. Our results show that active users typically classified their trips once or twice a day.

Classifying trips was not necessarily correlated with viewing results; sometimes, users would view just the results, showing some level of engagement.

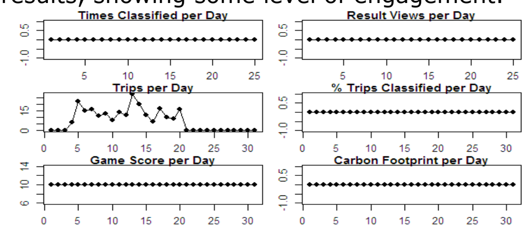

Figure 7. Inactive User

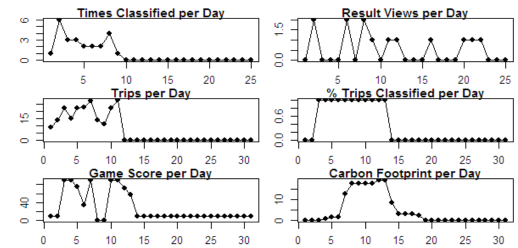

Figure 8. Semi-active User

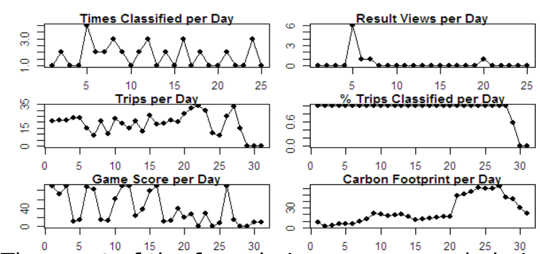

Figure 9. Active User

Three out of the four choice users overwhelmingly preferred the data results view, each spending over ninety percent of their time in the app looking at it. The fourth user, however, went the other direction, spending over ninety-nine percent of the time in the gamified view. The consistency of these four users' behavior validates the earlier results regarding the heterogeneity of behavioral interventions and indicates that allowing users to preference match is more effective than choosing a visualization for them. The remaining two users did not end up switching views at all.

While choice users may not have spent a lot of time in the data view, Figure 6 illustrates their result view switching behavior. It shows that while one user switched views once and never switched back, other users continued to switch views back and forth view for the duration of the study period. Circles indicate overlapping Xs that are small intervals when users viewed a particular result screen and then switched back.

Future Work

The primary focus for future work is around improving recruitment. We need to broaden our sample population to be larger and also be more representative of the general population. In addition, we can improve the data and game screens displayed to the users by making them more intuitive.

Conclusion

It is challenging to motivate users to make lifestyle changes at the individual level in order to achieve large societal goals. We explore three approaches based on techniques drawn from behavioral science to display user data and measure their effect on user engagement. One approach is data oriented, the second converts the data into a game, and the third approach allows users to choose between the two options. Based on a sample of 20 people, we see that users who were allowed to choose their preferred visualization were more engaged, they typically picked one approach and stuck to it, although they periodically sampled the other to ensure that their choice was correct.

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