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Joey J. Lee, Pinar Ceyhan, William Jordan-Cooley and Woonhee Sung

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# GREENIFY: A Real-World Action Game for Climate Change Education

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Joey J. Lee<sup>1</sup>, Pinar Ceyhan<sup>1</sup>, William Jordan-Cooley<sup>1</sup>,  
and Woonhee Sung<sup>1</sup>

## Abstract

The literature on climate change education recommends social, accessible *action-oriented* learning that is specifically designed to resonate with a target audience's values and worldview. This article discusses GREENIFY, a real-world action game designed to teach adult learners about climate change and motivate informed action. A pilot study suggests that the game fostered the creation of peer-generated user content, motivated informed action, created positive pressure, and was perceived as a fun and engaging experience.

## Keywords

accessibility, actionable knowledge, action-based learning, civic action, climate change, crowdsourcing, design rationale, empathy-based action, empowerment, engaging experience, gamification, informed action, peer-generated user content, pilot study, positive peer pressure, relevance, real-world action game, social networking

Despite effort spanning several decades to mobilize the public around the issue of climate change (e.g., Nisbet, 2009), few people take action to mitigate personal emissions (Owens, 2000), and climate change remains low in voters' listing of national priorities (Leiserowitz, 2006). This reluctance to take action is often explained by an *information deficit* model (Bell, 2005; Burgess, Harrison, & Filius, 1998), which cites gaps in knowledge, including incomplete or erroneous understandings of the causes of global warming (Bord, O'Connor, & Fisher, 2000; Bostrom, Morgan, Fischhoff, & Read, 1994; Fortner, 2001; Seacrest, Kuzelka, & Leonard, 2007; Sundblad, 2008). However,

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<sup>1</sup>Columbia University, New York, USA

## Corresponding Author:

Joey J. Lee, Department of Mathematics, Science and Technology, Teachers College, Columbia University,  
Box 08, 525 W 120th St., New York, NY 10027, USA  
Email: [jlee@tc.columbia.edu](mailto:jlee@tc.columbia.edu)

achieving a better public understanding of climate change does not necessarily lead to the desired behavior change (Finger, 1994; Leiserowitz, 2006; McKenzie-Mohr, 2008; Owens, 2000). Some studies have even found, perhaps counter-intuitively, that *better-informed Americans are less likely to take personal action rather than more* (Kellstedt, Zahran, & Vedlitz, 2008; Moser, 2006).

Broadly, the literature suggests that future education efforts include action-based learning and consideration of the individual within their socio-cultural contexts. First, major barriers to climate change education efforts include polarization of opinions along ideological lines (Nisbet, 2009) and distrust of institutional sources of information (Nisbet, 2009; Owens, 2000). As such, climate change messages should be tailored to resonate with the worldviews and values of each target audience, ideally developed and delivered among peers (Leiserowitz, 2006; Nisbet, 2009; Owens, 2000). Second, effective behavior modification leverages normative and committing power of social groups rather than focusing on the individual (McKenzie-Mohr, 2008). Third, knowledge acquired in an action-based and meaningful context promotes behavioral change (Epstein, 1994; Cordero, Todd, & Abellera, 2008; McKenzie-Mohr, 2008) by building self-efficacy (Nisbet, 2009; Owens, 2000) and forming the individual and social basis of new behaviors (McKenzie-Mohr, 2008).

## Design Rationale for the GREENIFY System

New technologies have created the opportunity to develop a new intervention for climate change education based upon the above recommendations found in the literature. A team of educational technology experts set out to design such an intervention. Based upon four key goals, a number of design features were conceived (see Figure 1 for an overview of the design process). This section will highlight these underlying goals and briefly describe the corresponding design features created to address these goals. The interplay of the design features and the overall user experience will be explained in more depth in a later section.

### Goal 1. Accessibility and Relevance

*Messages developed and delivered among peers.* An effective climate change education strategy needs to provide information that users feel is relevant to their values and worldview. The ability of a persuasive message to have the desired effect depends largely on how the framing of the message appeals to the target audience. For example, a number of religious leaders, using a moral and ethics frame, emphasize a “duty to be ‘stewards’ of God’s creation,” effectively appealing to their followers (Nisbet, 2009, p. 21). Broad appeals designed for general audiences often cannot resonate as strongly as those tailored for more specific groups and demographics.

Climate change education has traditionally been undertaken by large institutions like governments and nongovernmental organizations. These organizations can have difficulty generating the necessary diversity of messages to appeal to the corresponding



Figure 1. Design rationale

diversity of audiences and tend to rely on these more general forms of appeals. Peer-to-peer knowledge transfer can be a strategic way to solve this problem.

Social networking sites (e.g., Facebook, Twitter) enable the formation of online communities built upon common interests and values, which generate and share enormous varieties of content that is by nature relevant and meaningful to the constituent groups. For instance, Wikipedia users have created one of the most extensive encyclopedias in the world with over 18 million articles in 279 languages and 400 million monthly users (Cohen, 2011). These articles support a wide array of niche interest groups, from quantum physics to WORLD OF WARCRAFT.

**Design Features That Promote Accessibility and Relevance.** The GREENIFY system seeks to harness this generative power to create messages on climate change that can appeal to the enormous variability of worldviews and values. This is accomplished by allowing and motivating players to populate the site with user-generated content. Players create *Missions*—practical ways to take action in everyday life—and *Explore* articles—ways to learn about the issue (Figure 2). The intended result is a crowdsourced, collective knowledge-sharing environment populated with messages that can speak to and inspire a diverse audience.

**Goal 2. Positive Peer Pressure**

*Leverage normative and committing power of social groups.* Creating a culture of positive peer pressure (Smith & Fowler, 1984) may be a viable strategy for promoting sustainable changes in behavior and mind-set. Just as support groups have been effective in employing social psychology to affect behavior in contexts of substance abuse, there is power in using groups to provide accountability and transparency for one’s actions (Mohnen, Pokorny, & Sliwka, 2008). These mechanisms of group behavior constrain individual actions around group norms and values. Creating social groups around individuals, which normalize desired behaviors, can be a powerful strategy for affecting behavior change.

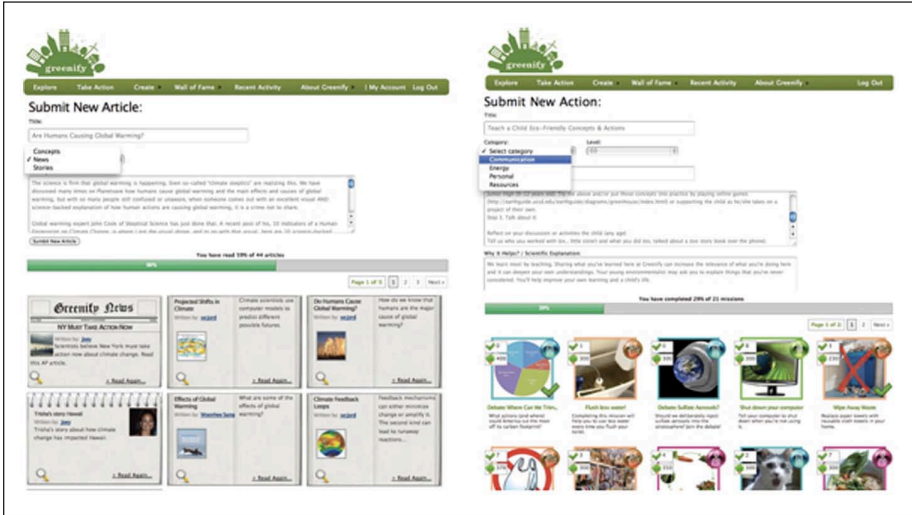


Figure 2. Creating a new *Explore* article and *Mission*

The online interaction afforded by environments like Wikipedia creates a community with a common purpose and relatedness, resulting in motivating contributors and even a sense of reciprocity and altruism (Kuznetsov, 2006). Coupled with the ability of social media to connect individuals of similar backgrounds and lifestyle, online environments show promise for creating social groups with a shared interest in climate change.

**Design Features That Promote Positive Peer Pressure.** Several design features were developed in order to create a culture and community that value discussions about climate change and make sharing knowledge—and taking action—a socially commendable thing to do. These features include the ability to see recent activity by other users in a news-feed format, a publicly viewable profile and status, and the ability to show appreciation and give positive feedback (e.g., a *Thumbs-up* button shown in Figure 3).

### Goal 3. Informed Action

**Practical everyday steps for making a difference.** Most climate change education strategies focus on increasing understanding of the broad problem. This does not necessarily lead to action (Kellstedt et al., 2008; Moser, 2006). Recommendations for future efforts in climate change education suggest *action-oriented learning* that connects understanding of the broader problem with actions that the player can immediately take in his or her own life. A system that provides practical, immediately actionable knowledge can be a promising approach to encourage sustainable changes to one’s lifestyle. As McKenzie-Mohr (2008) demonstrated, when people have done something once, they are more likely to do it again.



**Figure 3.** Sharing completed deeds and showing appreciation

*Empathy-based action.* Increasing empathy can be another good way to encourage behavior change. Kim, Hong, and Magerko (2010) found that when people saw the consequences of their behavior on the health of another living creature—even when virtual—they were more likely to adjust their behavior. For instance, participants decreased home electricity usage once they saw the impacts of their actions on the health of a virtual coral reef (Kim et al., 2010). Providing stories, images, and personal accounts of the impacts of climate change may also be an effective strategy to promote empathy and informed action.

**Design Features That Promote Informed Action.** The GREENIFY system challenges players to complete real-world missions in four categories: *personal* (e.g., choosing green product choices), *energy* (e.g., transportation choices), *resources* (e.g., usage of water and electricity), and *communication* (e.g., debating issues and sharing knowledge with others). Players complete missions by demonstrating their completed deeds to others in the form of photos or written descriptions. In doing so, they earn *Tree points*. The GREENIFY system was also designed to empower players to make a difference: Players are able to create actions for others to complete, and they receive points when others complete these actions. They are given a sense of ownership as the featured author of actions and articles.

Finally, several elements were built into the GREENIFY system in order to promote empathy-driven behavior change (Kim et al., 2010). These include polar bear pets whose happiness and status correspond to a player’s actions and personal stories in which people can share videos or written testimonials of how climate change affects their lives.

### Goal 4: Fun, Engaging Game Experience

Gamification, defined as the use of game-like elements and principles to engage users in real-world activities (McGonigal, 2011; Schell, 2010), provides an important opportunity for motivating and scaffolding climate change-oriented actions in everyday life. As an example of the power of gamification to motivate action, NIKE PLUS allows runners to

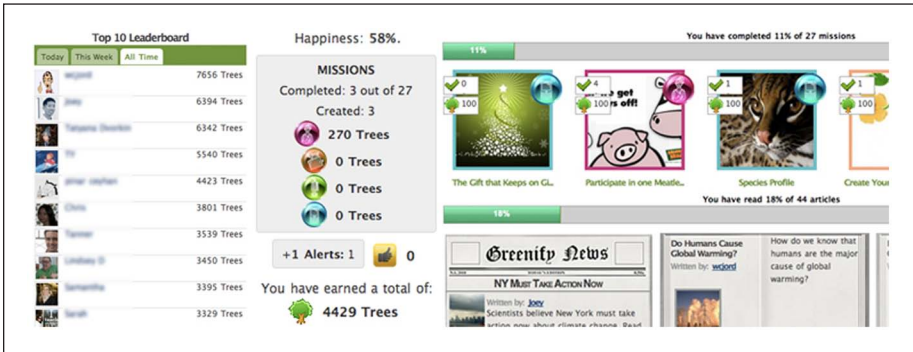


Figure 4. Leaderboard, player profile, mission and explore progress

set goals, join challenges, and connect with friends in the online community, and since its launch in 2006, it has motivated users to run over 262 million miles (Malinowski, 2010). Gamification, when coupled with social features, can be a good way to encourage desired behaviors and habits through positive motivational psychology.

In addition to motivating action, principles of good game design are consistent with contemporary learning theories and can be used to build experiences that guide players to mastery of complex and difficult material (Gee, 2005). Congruent with recommendations of action-based learning from the fields of climate change education (e.g., Cordero et al., 2008) and instructional design (e.g., Merrill, 2007), good games recruit good learning because they facilitate learning through completion of actions and authentic tasks (Gee, 2011).

**Design Features That Promote a Fun, Engaging Game Experience.** The GREENIFY system was designed with engaging game elements (displayed in Figure 4). These include the ability to earn points for completing and creating *real-world missions*; a *leaderboard* that displays top scores daily, weekly, and all time; a *player profile* with progression mechanics; and a page that provides recognition for top-rated content and deeds.

### The GREENIFY Experience

The above design features were integrated into a website with three main sections: *Explore*, *Take Action*, and *Create* (see Figure 5 for an overview). In addition to these core sections, the website features a *Recent Activity* feed and a *Wall of Fame*. The flow of the user experience is discussed in this section.

Players could read three kinds of articles within the *Explore* section as shown in Figure 6: *News*, *Scientific Concepts*, and *Stories*. *News* articles included a brief summary and links to recent news articles on climate change. *Scientific Concepts* taught players about fundamental climate change concepts such as albedo and the greenhouse effect through videos and interactive media (e.g., simulations and mini-games).

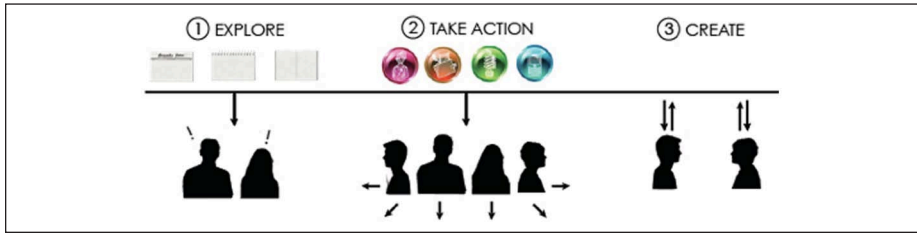


Figure 5. Explore articles, Take Action (missions), and Create new content



Figure 6. Main page, with Explore articles and Take Action (missions) sections

Finally, *Stories* included personal accounts of how climate change has impacted others' local environments. The *Explore* section served as a crowdsourced, collective knowledge-sharing environment since it enabled sharing articles from external resources. Players could view highly rated *Explore* articles and boost article ratings by pressing a +1 *Alert* button, thereby boosting the article's *Alert* score.

In the *Take Action* section, players could browse and accept real-world missions in four categories: *Personal*, *Resources*, *Energy*, and *Communication*. Missions were user-generated and varied from practical everyday actions that reduce carbon emissions to missions that involved problem solving or sharing creative ideas to complete. All missions featured step-by-step instructions and a *Why it Helps* section that explained the impact of the mission. Completing missions involved doing whatever real-world task is involved as well as documenting your solution in the *Deed* log. Players earned a number of *Tree* points for completing missions. Missions were rated by all players for their potential impact, and the average rating score was displayed; highly rated missions yielded a greater number of *Tree* points when completed. *Deeds* (players' completed missions) were also viewable and could earn "Thumbs-Up" votes.





**Figure 7.** Polar bear avatars and their status

The *Create* section encouraged players to create new *Missions* and *Explore* articles for others. Submitted missions and *Explore* articles were vetted and approved by a team of climate science experts before they became live and playable on the site. Importantly, GREENIFY was designed to inspire players to want to enact change among their social circle; players earn a number of *Tree* points for creating missions, and earn more points when their missions are rated highly and each time missions are completed by other players. In this way, the game naturally encouraged people to take ownership over climate change issues and inspired players to want to create high quality, scientifically sound, practical actions for their peers.

The *Recent Activity* section featured a news feed that displayed recently completed missions and updates. Players could comment on each others' activities, initiate and accept friend requests, and share status updates. The *Wall of Fame* displayed badges and superlatives in the form of top scorers and most popular missions. Finally, leaderboards and player scores displayed the players with the daily, weekly, and all-time high scores for *Tree* points.

The polar bear avatars were an emotionally engaging visualization of the frequency of a player's actions within the game (see Figure 7). The polar bear was chosen due to its popularity as an iconic animal of the Arctic region. The sea ice on which the bear resides represented the bear's natural habitat, which is shrinking as a direct result of climate change. The purpose of the polar bear avatar was to give the player (1) immediate feedback on real-world and in-game impact and (2) embodied feedback in a form for which the player could build empathy and a feeling of responsibility. The polar bear had three emotional states corresponding to its happiness level: sad, neutral, and happy. Frequent completion of missions increased the *happiness score* of the player's pet polar bear avatar. Inactivity on the site slowly shrunk the sea ice level and in turn decreased the polar bear's happiness. Another metric of the polar bear's state, *intelligence level*, was increased by reading *Explore* articles. The bear's *intelligence level*

displayed to the player in qualitative descriptions: *illiterate bear*, *baby bear*, *junior bear*, *senior bear*, and *smart bear*.

## Method

Upon designing and developing a working prototype, a formative assessment was conducted using Design-Based Research (DBR) methods (Design-Based Research Collective [DBRC], 2003). This served two primary purposes: (1) to explore the feasibility and potential value of a social, crowdsourced, gamification-based system for climate change education and (2) to iteratively develop and test such a system. The reader should note that the purpose of the study was to guide design; therefore, the generalizability of results is limited. Four research questions were investigated as part of an exploratory pilot study, aligned with the four design goals developed from the recommendations of the climate change education literature:

*Research Question 1: Can GREENIFY foster the generation of messages that are accessible and relevant to the community of users?*

*Research Question 2: Can GREENIFY create positive peer pressure on climate change issues?*

*Research Question 3: Can GREENIFY promote meaningful action?*

*Research Question 4: Do players perceive GREENIFY as a fun, engaging game experience?*

In all, twenty-six adults from two graduate-level courses at a large private university in New York were selected as part of a convenience sample. As the sample size was small, significance testing was not appropriate. No compensation was provided for participation; participation was fully optional and had no bearing on grades. A total of 8 men and 18 women participated in the 6-week study. Ten students were enrolled in a doctoral program in instructional technology, while 16 were master's students. Two students self-identified as Black, 9 as Asian, and 15 as White. All student names have been replaced with same-sex pseudonyms.

Participants were given a pre- and postimplementation survey, each with three types of questions: 12 questions testing basic knowledge about climate change, 15 Likert-type scale items (7-point scales ranging from *completely disagree* to *completely agree*) exploring attitudes, 7 Likert-type scale questions looking at participant behaviors; 3 open-response essay questions; and 10 questions about the GREENIFY design and what players perceived as its impacts on their behaviors, attitudes, and knowledge. Semistructured interviews were also administered to six students, focusing on the positive and negative aspects of the experience, and the effects of the game on their behavior and what they learned. The six interview respondents were chosen based upon their self-reported level of prior climate change knowledge: two participants with high knowledge, two with medium, and two with low. In addition, in-game logs recorded various player data related to gameplay. These included the number of missions

accepted, completed, and created; the number of *Explore* articles read and created; and the number of *+1* ratings and *Thumbs-Up* ratings.

## Findings

The following section presents the findings of the four research questions.

### Research Question 1: **Can GREENIFY foster the generation of messages that are accessible and relevant to the community of users?**

Content was generated by players in the forms of *Missions*, *Deeds*, and *Explore* articles. In the 6-week period of gameplay, 27 *Missions* and 44 *Explore* articles (*News*, *Stories*, and *Scientific Concepts*) were created and read 595 times. *Mission* completion led to 193 *Deeds*—anecdotal experience of the activities and personally relevant user stories.

Within the limited sample, trends suggest that this peer-generated content was meaningful and relevant to their lives. In survey responses, 46.2% of participants agreed that they were far more aware of how their lifestyle and actions impact the environment. When asked whether they believe their actions contribute to global warming and climate change, 88.5% agreed. Most importantly, players reported feeling more empowered, as they reported a new understanding that individual actions can make a difference:

For me, it just opened my eyes to how much energy I consume and waste at home by leaving my monitor on, never looking into residual power draw for equipment I haven't used in weeks. (Winnie, female)

Actually, I didn't pay any attention about global warming and all the environmental issues before. But now by playing GREENIFY I actually pay more attention about little things and knowledge, like I actually didn't know the ordinary activities I do can change things. (Han, female)

I did them [missions] not just because of the [Tree] points but also because of my own awareness about the issue of climate change. (Lynn, female)

By combining general knowledge with specific actions that people could take, GREENIFY seems to have increased personal relevance and accessibility, giving players a sense of meaningful accomplishment and reducing the feelings of fatalism common to the issue. Furthermore, the missions provided easy, bite-sized actions that helped players overcome the feeling of being overwhelmed when dealing with such a large and complicated issue.

### Research Question 2: **Can GREENIFY create positive peer pressure on climate change issues?**

A total of sixty-one percent of players expressed that sharing knowledge, ideas, and deeds within a social network was a very positive and motivating experience. Social interactions (e.g., commenting on others' missions and deeds) were perceived by most players to be valuable. For instance, players said they are motivated when "seeing others' strategies" and "watching others' activity." Players remarked, "The crowdsourcing aspect is great. It gets so many people involved"; "[I enjoyed] learning in GREENIFY [and] seeing other people are learning too"; "It allows being green to become part of a social network"; and "[The game] lets me see how other people I know are doing [actions] to care about this issue."

In some cases, this kind of positive peer pressure went beyond the players of the game itself. In her interview response, Cindy (female) talked about how the experience extended into her apartment and to her roommates—people who were not even participating in the online game:

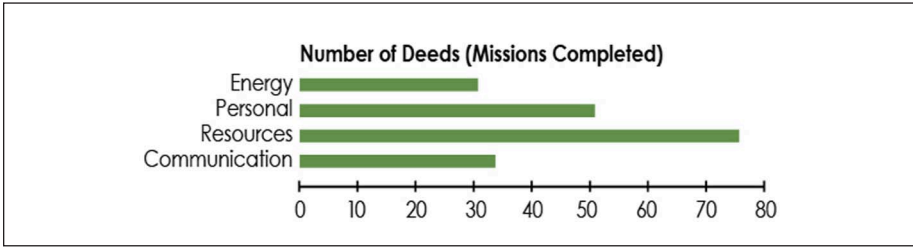
I think taking the actions and applying them in your actual life makes the game live beyond the computer. I know for myself I've taken some of these action challenges and posted [them] with friends or roommates—so it almost lives in my apartment or in my everyday life and beyond. You know, which kinda makes it fun and kinda engages roommate conversation. So I think it's good kinda talk at recess or talk outside of the game itself on the computer and kind of go 'oh, how did that go for you?' or talk about the actual actions.

Within the limited sample, 65.4% of participants agreed that the peer teaching and learning afforded by GREENIFY motivated players to want to teach others about climate change more. Survey responses and interviews revealed that a few players pointed to the power of collective actions, which changed their opinion about the role and impact of individuals. For instance, Lisa (female) said,

I think the real power is just kind of in the interaction. So I've talked to people in the site they have posted links to things or posted articles that I may not have stumbled upon on my own; so I think I've picked up some pretty cool knowledge that I didn't have before.

### Research Question 3: **Can GREENIFY spur meaningful action?**

In-game behavior logs revealed that during 6 weeks of gameplay, 27 missions were completed a total of 193 times (see Figure 8 for a breakdown of deeds by category). Nine *Resources* missions, including missions that challenged players to reuse bags for shopping purposes and to create homemade eco-friendly cleaning products, were completed (a total of 76 times). Six *Personal* missions, including missions to donate unwanted items or to eat organic and vegetarian meals, were completed 51 times. Three *Energy* missions, including shutting down the computer when not using it, and choosing to take public transportation to work instead of driving, were completed 32 times. Nine *Communication* missions, characterized by peer communication-based



**Figure 8.** Breakdown of missions completed

tasks such as debating climate change issues and sharing news, information, and photos, were done 34 times. Examples of *Communication* missions include *Debate: Where Can We Trim?* which asked players to discuss which economic sector and what specific actions could lead America to decrease its carbon footprint the most, and *Picture the Problem*, which allows players to earn points for uploading photos that highlight the problem of climate change.

In addition to game logs, survey responses indicated that our sample believed GREENIFY affected their everyday activities. Nearly all participants in the sample (82.6%) reported that GREENIFY changed their behaviors, with 13.8% reporting a score of *strongly agree* on 7-point Likert-type scale items. When asked what new behaviors resulted by playing the game, participants gave a wide variety of responses, including “Started talking about the issue more with friends and family. Did more reading about the topics found on GREENIFY and took a few challenges and incorporated them into my daily routines”; “Reduced the amount of beef I eat and made changes around the house to conserve energy”; “More recycling and thinking more about my actions prior to purchasing items that might impact the earth”; “Didn’t take plastic bags”; “used public transportation instead of a car . . . use more organic products”; “Donated clothing and other used goods”; “Complete missions created by others, not just for one time, I tried to continuously follow the missions in everyday life . . . changed my everyday behavior by saving water, electricity, and disposable goods”; “Use less water and electricity—I put post-it notes around my house reminding everyone to turn the lights off.”

Notably, Likert-type scale item responses determined that participants at least *somewhat agreed* in the post-survey that they became more careful about the kinds of foods (61.6%) and personal products (65.4%) they buy because of the issue of climate change (an increase compared with 46.1% and 46.2%, respectively, in the pre-survey). Furthermore, the number of players who reported taking practical steps to curb transportation-based emissions rose from 30.8% before playing GREENIFY to 50.0% after. In the end, nearly all participants (92.3%) reported that they took action as a result of their understanding of climate change (compared with 65.4% on the pre-survey), and half made solid efforts to make changes around the household because of climate change, compared with just over one third (34.6%) in the pre-survey.

GREENIFY players reported that the game experience helped them become more aware of how their actions impact the environment. For example, Sammy (female) in an interview explained how GREENIFY changed her awareness of personal habits and how she felt more empowered to do simple actions to make a difference:

I'm a little bit ashamed but actually I would let the water run whenever I'm brushing my teeth everyday and I didn't feel bad about it. But now immediately after first time I saw the activity I stopped that. I definitely turn off [the water] when I'm brushing my teeth and . . . I feel good about it, I feel you know I'm really making an impact.

Similarly, Jenny (female) talked about household behavior changes because of GREENIFY missions:

I actually used to be one of those terrible people that left the computer running all the time with a dimmed screen or even asleep; it has got that residual power draw, you know. I've got a big 27" screen iMac at home, so that's throwing a lot of power. So after reading one of the challenges last week, I started shutting that down every time I leave the house. I'm sure I'll notice a difference in the power bill so that'll be nice. But I know that it'll make an impact for the rest of us, which is more important to me.

Game logs, survey responses, and interviews suggest that GREENIFY prompted players to take a variety of actions. Based upon the literature, this is a positive first step toward forming new behaviors.

#### Research Question 4: **Do players perceive GREENIFY as a fun, engaging game experience?**

Importantly, GREENIFY was viewed as a fun experience for nearly all participants (79.3%). A frequency-based word cloud based on user survey responses for "What do you think of GREENIFY?" was produced (Figure 9). The most frequently used words were *informative*, *interactive*, *fun*, and *actions*, followed by *practical*, *social*, and *engaging*. It can be determined that GREENIFY was largely viewed as a fun and engaging experience.

When asked how GREENIFY compared with other climate change education strategies, players' responses were very favorable; 86.2% of survey respondents felt GREENIFY was better than other climate change education strategies. Annie (female) remarked,

[GREENIFY] makes it very visual, it makes it very immediate and it makes it very plain. Like you can literally go on to the site, click on an action, click on a mission and find out what you need to do and what happens in the world as a



Figure 9. Word cloud for “What do you think of GREENIFY?”

result of your actions, and I think that’s very different than most things you hear. You can watch a video and get told 20,000 different things you should be doing. But this [GREENIFY game] gives you a focus so you can go and focus on one thing that day and make a real change. I think that’s pretty powerful.

### Discussion

Following the recommendations of the literature on climate change education, a social, gamification-based system was designed to form an online community engaged in peer-to-peer and action-oriented learning. Pilot tests suggest that gameplay helped players realize the importance of their personal actions, with reports of new behaviors and an increased desire to educate others on the website and beyond. These findings suggest that (1) gamification principles are congruent with needed changes to climate change education efforts and (2) social media technologies can enable peer-to-peer education and can motivate behavior change effectively. Gamification can be a powerful strategy that converts serious real-world problems into engaging and meaningful gameplay that promotes peer-to-peer education and behavior change through social interactions.

One of the limitations of this study is the possibility of an expectation bias. Some participants likely do not want to look like they are bad citizens in front of the researcher or their peers. Therefore, it is possible that participants may not have answered questions with full honesty or that they may have adjusted their responses to try to please the researcher. The use of triangulation of the multiple data sources (interviews, gameplay logs, and surveys) is one safeguard that may limit this possibility. It is unlikely for a player to speak about many practical actions taken when the game logs demonstrate a small number of actions completed.

Another limitation is that of limited generalizability. As a DBR study, the conclusions of this study can only be applied to this specific context. Further studies are needed to unpack and determine which specific features of the intervention were most

important in contributing to its success. Once these features are fully developed and put in place, the full version will be released to the general public, and a large-scale study will be conducted on a much larger set of participants. This version will include the ability to post missions and deeds onto social networks such as *Facebook* and *Twitter*, thereby increasing the reach of the content generated in the system.

## **Conclusion: Reaching People by Empowering Them to Reach Their Peers**

This article offers a new way of leveraging the affordances of games, offering powerful opportunities to share new ideas and strategies, to see feedback on one's progress, to rally around a common goal, and to empower people to challenge their peers to take real-world action. An important contribution of this study is the design and development of an innovative artifact: a new system that allows people to share knowledge about climate change and practical ways to mitigate personal contributions to climate change. As traditional approaches to climate change education have not always proven effective, more work is needed in exploring similar innovative approaches utilizing new interactive, online platforms and game elements.

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### **References**

- Bell, D. (2005). Environmental learning, metaphors, and natural capital. *Environmental Education Research, 11*, 53-69.
- Bord, R., O'Connor, R., & Fisher, A. (2000). In what sense does the public need to understand global climate change? *Public Understanding of Science, 9*, 205-218.
- Bostrom, A., Morgan, G., Fischhoff, B., & Read, D. (1994). What do people know about global climate change? 1. Mental models. *Risk Analysis, 14*, 959-970.
- Burgess, J., Harrison, C., & Filius, P. (1998). Environmental communication and the cultural politics of environmental citizenship. *Environment and Planning A, 30*, 1445-1460.
- Smith, L. K. C., & Fowler, S. A. (1984). Positive peer pressure: The effects of peer monitoring on children's disruptive behavior. *Journal of Applied Behavior Analysis, 17*, 213-227.
- Cohen, N. (2011, May 23). Wikipedia. *The New York Times*. Retrieved from <http://topics.nytimes.com/top/news/business/companies/wikipedia/index.html>
- Cordero, E., Todd, A., & Abellera, D. (2008). Climate change education and the ecological footprint. *American Meteorological Society, 89*, 865-872.



- Design-Based Research Collective. (2003). Design-Based Research: An emerging paradigm for educational inquiry. *Educational Researcher*, 32, 5-8.
- Epstein, S. (1994). Integration of the cognitive and the psychodynamic unconscious. *American Psychologist*, 49, 709-724.
- Finger, M. (1994). From knowledge to action? Exploring the relationships between environmental experiences, learning, and behavior. *Journal of Social Issues*, 50, 141-160.
- Fortner, R. (2001). Climate change in school: Where does it fit and how ready are we? *Canadian Journal of Environmental Education*, 6, 18-31.
- Gee, J. P. (2005). Learning by design: Good video games as learning machines. *E-Learning and Digital Media*, 2(1), 5-16.
- Gee, J. P. (2011). Learning and games. *The John D. and Catherine T. MacArthur Foundation Series on Digital Media and Learning*, pp. 21-40.
- Kellstedt, P., Zahran, S., & Vedlitz, A. (2008). Personal efficacy, the information environment, and attitudes toward global warming and climate change in the United States. *Risk Analysis*, 28, 113-126.
- Kim, T., Hong, H., & Magerko, B. (2010). Designing for persuasion: Toward eco-visualization for awareness. In T. Ploug, P. Hasle, & H. Oinas-Kukkonen (Eds.), *Persuasive Technology: 5th International Conference, PERSUASIVE 2010, Copenhagen, Denmark, 2010, Proceedings* (pp. 106-116). Berlin, Germany: Springer-Verlag.
- Kuznetsov, S. (2006). Motivations of contributors to Wikipedia. *ACM SIGCAS Computers and Society*, 36(2), Article 1. Retrieved from <http://dl.acm.org/citation.cfm?id=1215943&dl=ACM&coll=DL&CFID=152468820&CFTOKEN=41515703>
- Leiserowitz, A. (2006). Climate change risk perception and policy preferences: The role of affect, imagery, and value. *Climate Change*, 77, 45-72.
- Malinowski, E. (2010). Adidas miCoach App Sets Sights Square on Nike+. *Wired Magazine*. Retrieved from <http://www.wired.com/playbook/2010/08/adidas-micoach-app/>
- McGonigal, J. (2011). *Reality is broken*. London, England: Jonathan Cape.
- McKenzie-Mohr, D. (2008). Fostering sustainable behavior: Beyond brochures. *International Journal of Sustainability Communication*, 3, 108-118.
- Merrill, D. (2007). First principles of instruction: A synthesis. In A. Reiser & J. Dempsey (Eds.), *Trends and issues in instructional design and technology* (2nd ed., pp. 62-71). Upper Saddle River, NJ: Pearson.
- Mohnen, A., Pokorny, K., & Sliwka, D. (2008). Transparency, inequity aversion and the dynamics of peer pressure in teams—Theory and evidence. *Journal of Labor Economics*, 26, 693-720.
- Moser, S. C. (2006). *Communicating climate change—Motivating civic action: Opportunity for democratic renewal* (Wilson Center Occasional Papers, Vol. 2). Climate Change Politics in North America. Retrieved from <http://www.wilsoncenter.org/sites/default/files/ClimateChange.pdf>
- Nisbet, M. (2009). Communicating climate change: Why frames matter for public engagement. *Environment: Science and Policy for Sustainable Development*, 51(2), 12-23.
- Owens, S. (2000). Engaging the public: Information and deliberation in environmental policy. *Environment and Planning A*, 32, 1141-1148.

- Schell, J. (2010). *DICE 2010 video of conference proceedings: "Design outside the box."* Retrieved from <http://g4tv.com/videos/44277/DICE-2010-Design-Outside-the-Box-Presentation/>
- Seacrest, S., Kuzelka, R., & Leonard, R. (2007). Global climate change and public perception: The challenge of translation. *Journal of the American Water Resources Association*, 36, 253-263.
- Sundblad, E.-L. (2008). *People's knowledge about climate change: Uncertainty as a guide to future commitments*. Department of Psychology, University of Gothenburg, Gothenburg, Sweden. Retrieved from [http://gupea.ub.gu.se/bitstream/2077/10509/4/gupea\\_2077\\_10509\\_4.pdf](http://gupea.ub.gu.se/bitstream/2077/10509/4/gupea_2077_10509_4.pdf)

## Bios

**Joey J. Lee**, PhD, is an assistant professor of technology and education at Teachers College, Columbia University. He directs the Real-World Impact Games Lab Group, part of the Teachers College Games Research Lab. He designs games and creates experiences that address social issues, help people learn, and promote real-world impact, including Scholars Quest, which turns higher education into a more structured, prosocial, peer teaching and learning-based experience, and Science City Heroes, which explore how game mechanics can promote science mindedness in urban New York City middle schools. He received his PhD from Pennsylvania State University. Contact: JL3471@tc.columbia.edu.

**Pinar Ceyhan** is a New York-based designer and a doctoral student at Teachers College, Columbia University. She earned her BFA in graphic design from Bilkent University, and MFA in design and technology from Parsons School of Design. Her main research interest lies in exploring the possibilities of playful interactions for behavior change and integrating social media in learning activities. Contact: pc2496@tc.columbia.edu.

**William Jordan-Cooley** is interested in games that facilitate understanding of STEM (science, technology, engineering and mathematics) subjects and complex systemic issues like climate change and politics. He holds a BS in applied mathematics from the College of William and Mary and has published work in the field of theoretical biology with the Virginia Institute of Marine Science. He is currently studying instructional technology and media at Teachers College, Columbia University. He is working with the Teachers College Games Lab on several games raising awareness and facilitating behavioral change surrounding climate change and its effect on the Arctic region. He also works with the GameUp team of BrainPOP in New York, NY. Contact: wcj2105@tc.columbia.edu.

**Woonhee Sung** is a doctoral student in instructional technology and media at Teachers College, Columbia University. She holds an MA in instructional technology from University of Texas at Austin and a BA in educational technology from Ewha Woman's University in Seoul, South Korea. Her research focuses on the role of cognitive aspects in learning with technology and the use of multimedia software for problem solving. Contact: ws2345@columbia.edu.