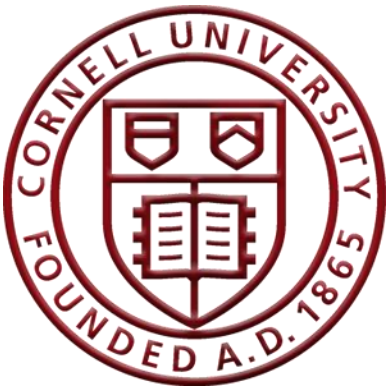
The Educational Role of Video Game Behavior on Individuals about Sustainable Strategies for Energy Conservation

A Master's Thesis Presented to

The Faculty of the Graduate School at

Cornell University



In Partial Fulfillment of

The Requirements for the Degree

Master of Science in Human Environment Relations

Concentration: Human Factors Ergonomics

By

Dan Moon

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Dedicated to the brave souls who dare to see the world for what it truly is. And then do something about it in their own way without regrets.

Acknowledgements

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BIOGRAPHICAL SKETCH

Dan Moon is a privately-educated student that experienced a global nomadic upbringing. After graduating from Seoul Foreign School, he pursued a neuroscience degree from the College of Wooster. After receiving his Bachelor of Arts, he pursued a Master of Science. He has now received his Master of Science degree in human factors & ergonomics from the College of Human Ecology within Cornell University. His primary specialty lies in digitized media interactions and their impact on cognitive neuroscience.

When we witness the wonderful nature of clouds…

One can understand just how miraculous existence can be…

Bringing forth new life, as it disappears…

Only to reappear as the same, but also unique, in yet another moment in time…

Because eternity is in the heart of the earth…

-Dan Moon 2018

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Abstract

This study proposed the use of video games as an intervention for providing an educational experience that targeted energy conservation behavior. The concept was rooted in the influence of virtual simulations on human cognition, in which the brain has not yet evolved to differentiate mediated experiences from real ones. The particular simulation (*7 Days to Die*) in question was set in a world with a fully destructible environment. Players allocated cognitive resources to avoid hunger, dehydration, and rise/drop in internal core temperature, which are vital health measures. Threats to survival presented themselves in the form of food scarcity, hypothermia, and even gravity. I hypothesized that this simulation would provide an engaging experience that, upon reflection, will shift attitudes, feelings, and intentions towards current real-world threats to environmental sustainability, specifically energy conservation during resource depletion. The common person should know where the energy that supports their livelihood is generated, and also be mindful of what resources are irreversibly consumed in the process. However, this importance does not guarantee that the common person will participate in energy consumption behaviors in the best possible way, especially when inconvenient. That is, the immediate benefits are more important than the costs in the uncertain future. This uncertainty is the root of plausible deniability of decision-making that results in environmentally unfavorable energy consumption behaviors. In this study, participants were provided examples of certainty via this simulation, where the support structures responsible for providing convenient means of survival are no longer available. This was meant to bring perspective into peoples' lives by eliciting a real-time emotional response to the disturbing and frightening causal conclusions of environmentally damaging behavior, such as failure to comply with energy conservation behaviors at the individual level.

Introduction

Why is this study important?

The primary objective of this study was to add to the existing body of literature on intervention tools as a form of education on sustainable strategies of energy conservation. Real people cause many sustainability-issues, be it at industry, institutional, or individual levels. Engaging in behaviors that place unnecessary strain on the environment causes an irreversible depletion of our natural resources. Our pursuits to benefit humanity came with costs. One notable example was the introduction of man-made greenhouse gases that stayed in the Ozone, because of chlorofluorocarbon emissions. Chlorofluorocarbon synthesis was essential for refrigeration. It took fifty years before we introduced policy to ban production of these environmentally hazardous chemicals. Fifty years of damage that first had to be identified before it was discussed, and then halted.

As a species, we survived an ice age. Can we survive a fire age? Many religious beliefs prophesize a lake of fire at the end of time, and with global warming, we may abstract these two concepts and foresee an end to the time of human life on parts of this Earth. We also survived a Great Flood. But can we survive the Gradual Flood? Venice might be inhabitable in a few lifetimes because of a sharp increase in rising sea levels. Natural disasters are also currently increasing in severity. This may be out of human hands, but it does not help that we have polluted our sea with an island of garbage that is the size of Texas. Therefore, sustainable behaviors are necessary for all people in their daily lives, in order to halt exacerbation of environmental decay. However, convenience may be enough to override these executive decisions, regardless of environmental decay. Innovation efforts that introduce novelty to our

luxuries, as well as basic human necessities, make it difficult to consistently discern whether or not these novelties will be a long-term detriment for a short-term gain.

Why video games?

We must redirect innovative efforts that introduce something new into every home and keep something old that every home resides in, which is this 4.6-billion-year-old planet. But these two efforts can join. In this study, this was done by using video gaming as a stimulatory intervention tool. The reasoning was simple: In order to change behavior, one must change behavior.

Over the course of a few decades, video gaming has evolved into a popular cultural phenomenon that boasts a high immersive value and has made its mark on the entertainment industry as a top competitor. However, research on the role of video games has been largely limited due to the use of self-reports. Self-reports that do not account for a person's background are limited in that every person has a different experience and outlook. This may or may not affect how much they will change their behavior. This can be assumed to be true for research inquiries regarding video gaming and sustainability.

What does this mean for resource depletion and sustainability?

Our brains interact with this reality by manipulating a physical form that can manifest its own vision. Now that we can project digital forms with computers that are capable of running an open-world simulation with a fully destructible environment, dynamic human vital statistics, and behaviorally diverse interactions, our brains interact with this reality by consciously manipulating a digital avatar. Motor output to us is now human input to a computer. Sensory input to us is digital output to a computer. What went out, goes in, and what goes in, comes out.

This is the behavioral feedback loop that is now in play in our shared reality, and role-play is a way of observing this phenomenon.

Sustainable behaviors whilst consuming resources may not be instinctual. Human instinct is inherently self-interested first and foremost. Our evolutionary psychology supports our instinctual desires to prolong our own existence. As such, the behaviors are generally observed to be opportunistic, one-sided, and advantageous at the cost of another. Furthermore, deferred gratification requires sacrifice at the present moment, which may not seem favorable for acquiring short-term gains. This is how we can both witness and envision human impact on the local and global environment. Correcting this behavior relies on a consciously cognitive effort by the individual, who can also influence industrial and institutional organizations.

Video games have the immersive qualities to completely captivate the interest of a human being. Therefore, they are valuable as tools for affecting attitudes, perceptions, and behaviors, which also include sustainability. Voluntary re-allocation of cognitive resources is how one changes their own behavior. This phenomenon occurs for as long as the human is willing to continue. Increasingly sophisticated video game technology continues to evolve in the entertainment industry, and is now capable of directing the individual with an opportunity to adapt new forms of self-regulated cognition and behavior. Perhaps this will lead to lasting behavioral decision-making that can be abstracted from self-constructed mental frameworks obtained from playing video games, and then incorporated into new interactions within daily encounters.

Hypothesis 1 - Attitudes

Post-apocalyptic players will have a significantly larger shift in attitudes related to sustainability, specifically energy conservation, than people who did not play.

Hypothesis 2 -Perceptions

Post-apocalyptic players will have a significantly larger shift in perceptions related to sustainability, specifically energy conservation, than people who did not play.

Hypothesis 3 - Behaviors

Post-apocalyptic players will have a significantly larger shift in behaviors related to sustainability, specifically energy conservation, than people who did not play.

A concept map of the topics associated with this research is provided in Figure 1. Video game methodology is used as an educational tool for energy conservation and sustainability.

Concept Map

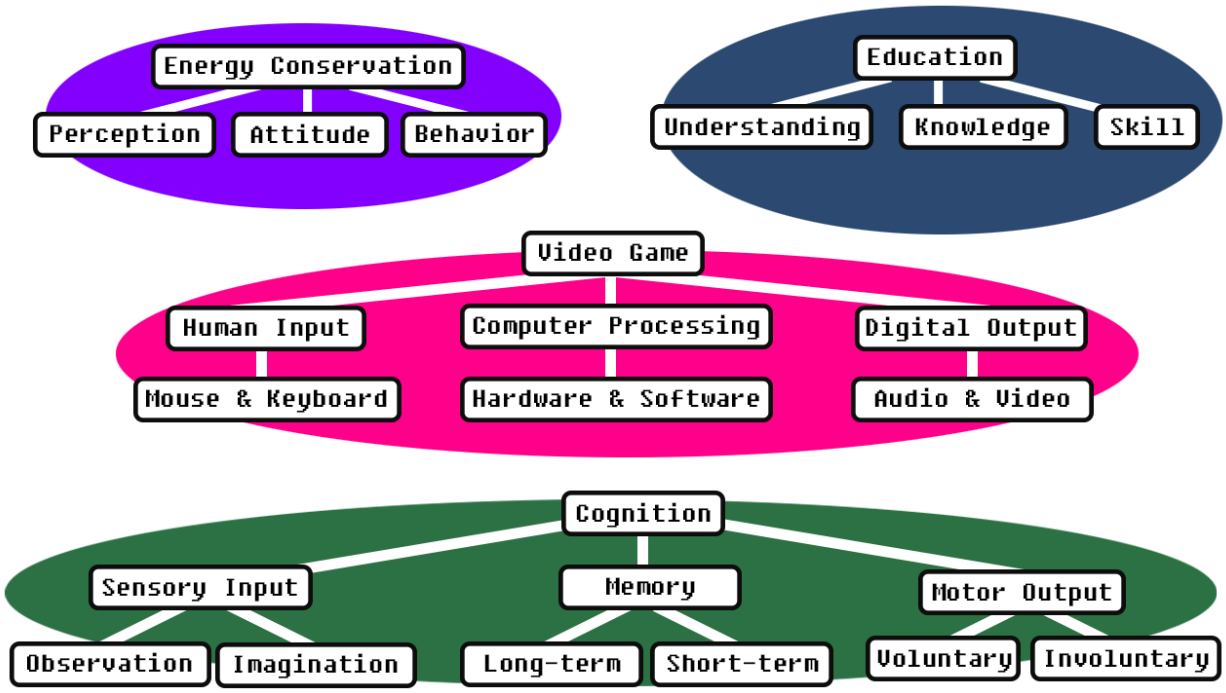


Figure 1: A concept map of the overarching themes with details that relate to perceptions, attitudes, and behaviors related to sustainability. Each heading depicts the components of concepts in order to draw a complete understanding of how these headings are related, within the scope of this research.

Literature Review

The literature review provided valuable insight on various aspects of learning and cognition through gaming included Cooper, 2014; Gee, 2003; Gee et al., 2008; Hayes et al., 2008; Shaffer, 2006; Spence & Feng, 2010; Wagner, 2016. The fundamental aspect of all of these studies was that by using games, individuals were able to redirect cognitive resources to immerse themselves into the necessary mindset required to successfully complete in-game objectives. This had serious implications for behavioral research primarily because the emotional impact on the diencephalon (thalamus, hypothalamus, and limbic system) may vary, but the underlying cognitive reasoning and decision-making processes all stemmed from the same prefrontal cortical activity that determined behavioral output. In other words, whether it was a real scenario or not, the telencephalon (cerebrum) still worked to solve a problem in any given situation. Therefore, it was imperative to understand how this was an opportunity to study the effects of role-playing on human behavior in a virtual simulation, without subjecting participants to ethically challenging role-playing simulations such as the Stanford Prison Experiment (Haney, Banks, & Zimbardo, 1973, n.d.).

The primary focus of the research reported on here was to usevideo game behavior as a tool to measure changes in attitudes, feelings, and behavioral intentions towards energy conservation. The literature concerning this matter was scarce, but there were many sources of survey data that identified these energy conservation traits cross-culturally (e.g., Barr, Gilg, & Ford, 2005; Cotton, Shiel, & Paço, 2016; DeWaters, Qaqish, Graham, & Powers, 2013; Hara, Uwasu, Kishita, & Takeda, 2015; Lee, Lee, Altschuld, & Pan, 2015; Nguyen, Lobo, Nguyen, Phan, & Cao, 2016). These researchers found that people are not compelled by current

educational interventions enough to prolong these behavioral shifts to the point where it changed their decision-making processes in the long-term.

There was, however, an educational game that simulated the various at-home causal conclusions in which the topic of energy conservation is presented (Dorji, Panjaburee, & Srisawasdi, 2015). This was explored as an effort to improve student learning and awareness in electric energy consumption and conservation. The results suggested that shifts in awareness were due to information provided, along with the opportunity, to be more aware of their own energy consumption behaviors. However, the most important impact it had on students was in the satisfaction of the experience. This was depicted with satisfaction ratings. Therefore, this inquiry shed light on the importance of the emotional impact a video game on energy conservation attitudes, feelings, and behaviors. The most salient factors in any video game were whether or not people would repeat play or refer the game to a friend. Word of mouth is how a message is spread, and how objectives are shared. This was related to lowering the likelihood that they would disregard the game as a nominal or inconsequential experience.

Other approaches to promoting energy conservation have been done through non-video gaming means. One example is through a “nudge,” in which hotel guests were encouraged to conserve energy through a competitive scenario that compared energy consumption between general guests and peers (Chang, Huh, & Lee, 2016). This nudge was not a game itself, but it did provide a feedback component that aimed to increase energy consumption awareness. This study highlighted the effectiveness of attempting to approach the same situation through variations of a scenario, be it positive or negative. The inclusion of an energy consumption feedback system resulted in significant differences in energy consumption between guests with feedback on the others’ energy consumption behavior when compared with those who were not provided this

feedback. The participants were told that the feedback system would be a digital display with metrics on theirs and other guests' usage of energy, such as heat and electricity. However, the primary point of criticism in this study was that the technology itself was not present. Participants were given a scenario, rather than something tangible, such as a video game simulation. Yet, it still had an impact on shifting behavioral intentions and perceptions towards energy conservation.

Furthermore, points of criticism concerning self-reported survey data must be addressed. Ro, Brauer, Kuntz, Shukla, & Bensch, 2017, made purely quantifiable measurements of energy consumption. This particular six month-long longitudinal study used gamification. Gamification is defined as the application of game-design elements and game principles in non-game contexts. This was used as a method of treatment in order to determine effectiveness in shifting energy conservation behaviors and self-reports across time and provided compelling evidence that supported the claim that by providing information and opportunity within a competitive atmosphere, people made better choices related to energy conservation. The evidence was compelling because raw data such as at-home kWh consumption were measured. The observed significant differences were quantifiable, and has served as a cornerstone in other research (Asensio & Delmas, 2016). The self-reports gathered in this study were shown to significantly differ too. That is, the behavioral intentions and perceived importance of sustainability were more prominent in peoples' lives because of competition and rewards, with leaderboards that were announced publicly.

Other studies used various types of interventions to shift energy conservation behaviors (e.g., Chabalengula, Sanders, & Mumba, 2012; DeWaters et al., 2013; Koballa, 1984; Mirosa, Lawson, & Gnoth, 2013). These researchers examined the role of literacy, message framing,

prompt usage, attitudes, and even personal values related to energy conservation. However, the generalized conclusion one can make from this literature was that there have been various methods proposed to affect behavioral change, but unless quantifiable energy consumption data were included, the research was both speculative and uncertain to prolong these behavioral effects to the point of long-term behavioral change. Research costs associated with obtaining these figures within a large sample size were high. As such, the opportunities to observe these influences were scarce. Cost-effective research was needed to ensure acquisition of this data and can be presumed to be a challenge for research endeavors within this domain.

Additionally, research must target interventions with impactful responses. Therefore, the study described in this paper provided an experience with a simulated world. Participants were given the opportunity to draw conclusions from what they encountered within the game in regards to sustainable behavioral practices and mindset pertaining to energy conservation. With a real-time scenario in a video game that emulated an aftermath of the collapse of societal support structures responsible for maintaining their basic human necessities, individuals were faced with a reality where they must allocate cognitive resources in order to secure these necessities on their own. Such support structures included easy access to food, clean drinking water, and shelter.

Current progression for a more sustainable environment may not be as effective as they appear to be. We may believe that we are having a significant impact on the way people treat the environment with charities, educational public service announcements, and political mandates, when we are not. It is possible that we are not effectively addressing the empathy required for individual, institutional, and industrial establishments to prioritize sustainability in behavioral decision-making. If this is the case, then video game simulations could be an unconventional alternative that provides a much more effective impact on the general public in the pursuit of

sustainability, such as energy conservation. As a whole, people have not done the best that they should be doing to follow this progression towards a more sustainable environment. But through experience, it is not uncommon for a human being to exhibit contradicting behaviors and uphold opposing views over the course of their entire lifetime. The way these experiences are orchestrated continue to manifest themselves into our shared reality -- one that we simply cannot reset by starting a new game.

Methods

Participants

Sixty-three males (n = 28), females (n = 35), students (M = 24.2 years old, SD = 7.33) at the undergraduate and graduate level were recruited via SONA, convenience sampling, and flyer advertisement after IRB approval was acquired. The students served as the sample population of this study. These students were rewarded with extra credit from courses that offered this incentive. Consent was obtained through signed paper forms. Participants were fully debriefed on the purpose of the study at the end of their session.

Materials

A modified survey that originated from two previous studies (i.e. Koballa, (1984) and Mirosa et al. (2013) concerning energy conservation behavior and attitudes were administered to participants as a pre-test (Appendix B), and were also included in the post-test (Appendix C) and seven-day follow-up (Appendix D). It included a ten-point scaling unit and a five-star rating component. Moreover, a few more derivative inquisitions were added to include important items, such as meat consumption, to the survey because the topic of energy was broad enough to include them (Benders, Kok, Moll, Wiersma, & Noorman, 2006). Finally, the survey items were scrutinized to reflect student behaviors, since the population sample comprised of college-aged and graduate students.

A laptop computer with a 2GB GPU, 3.3 Ghz core i-5 processor, and 8GB of RAM ran the simulation. This game was a massive-scale open world with a fully destructible environment. It also integrated a deep, intricate crafting system for participants to use. The game was set in a post-apocalyptic setting where first-world humans could no longer rely on societal support

structures in order to survive. Therefore, the game presented participants with the opportunity to experience the daily struggle of vital statistic maintenance such as hunger. This was done by collecting in-game resources, and then consuming them.

By providing a synthetic certainty of starvation through a simulation, participants were given the opportunity to reflect on their individual behaviors, attitudes, and feelings towards sustainability within the realm of energy conservation. This was done with a post-test and seven-day follow-up that measured their attitudes, feelings, and behavioral intentions as well.

Procedure

Each trial consisted of one participant. After signed consent was obtained, the participant completed a pre-test survey in order to indicate their individual stance on sustainability, specifically energy conservation attitudes, feelings, and behaviors. This served as an indicator for a pre-disposition towards energy conservation. This took approximately five minutes. No personally identifiable data, such as a facecam recording, were collected. As such, they provided abbreviated versions of their real names for matching data between the pre-test, a post-test, and a seven-day follow-up survey. This was done to observe an immediate and long-term effect. In addition, demographic data such as age and gender identity were collected along with their previous video game experience.

There were two groups, active and passive participation. Active participation meant that the subjects played the game, while passive participation meant that the subjects did not play the game. This was the treatment and control group, respectively. A video tutorial on how to play the game was provided to both groups. It was created by the researcher and contained verbal instructions. This tutorial was the same for both groups and included demonstrations of same

tasks. The treatment group played the game itself after watching the tutorial. The control group viewed the tutorial, solely. This was done in order to observe the isolated effects of video game play, but also provide an understanding of the instructed tasks and game mechanics.

Participants were introduced to a computer game called, "7 Days to Die," and were given a brief overview of the in-game objectives via a fifteen-minute video tutorial. The tutorial provided a walkthrough of the controls, user interface, and of the task itself. They learned how to move and interact with virtual objects with the user interface (Figure 2a), and then used this knowledge to complete objectives. The main objective of the task was to create a piece of virtual corn bread for avatar consumption.

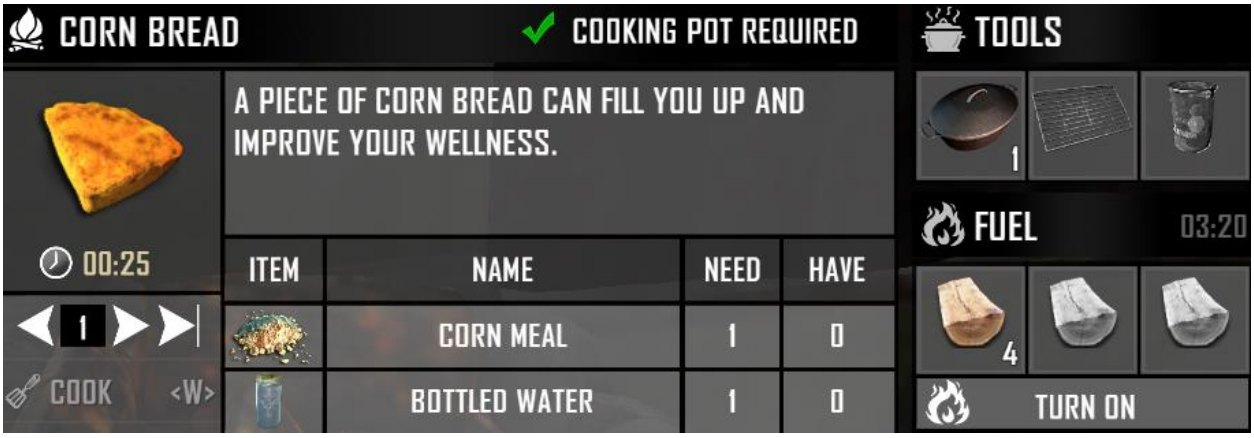


Figure 2a: User interface of "7 Days to Die," highlighting materials needed to craft virtual corn bread. Harvested wood provided fuel for the campfire. The timer indicated how much time was left before the campfire exhausted its energy and became unusable.

Hunger, among others, was a vital statistic (Figure 2b) within the game, and so they performed this task in response to the continual increase in hunger of their digital avatar.

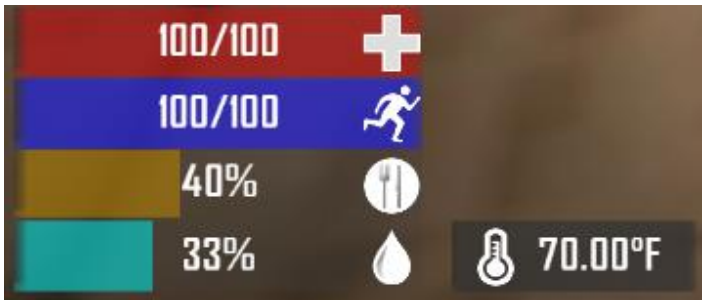


Figure 2b: Vital statistics were displayed on the main HUD. Health was in the red bar. Stamina was in the blue bar. Hunger was in the brown bar. Hydration was in the teal bar.

Moreover, sub-tasks were provided in order to complete the main objective. These sub-tasks formed the crucial components necessary to create virtual corn bread. This included harvesting wood (Figure 2c) from trees to burn on a cooking campfire, gathering murky water from a river for distillation, picking corn from a corn field, and then processing these raw materials so that corn bread could be created and then consumed.

Figure 2c: A player harvesting wood directly is shown the remaining durability of the tree before it collapses and permanently disappears.

Murky water had a significant chance of causing the avatar to become afflicted with diarrhea. This was an illness that negatively affects the avatar, just like how it would negatively affect humans. Upon completion of the main objective, participants witnessed a presentation of

the effects of consumption through a change of the hunger vital statistic within the user interface. Moreover, Figure 2d shows that participants were introduced to a light switch attached to a battery bank that displayed a finite amount of power remaining before the indoor overhead lighting could no longer function.

Figure 2d: A battery bank that supplied electricity to a power switch which regulated indoor overhead lighting.

The treatment group played the game from anywhere between ten to twenty minutes and depended on the quickness of the participants to complete the main objective. To put things into perspective, a full day in-game lasted twenty minutes. All participants in the treatment group were placed in the same virtual environment, which was an abandoned farmhouse that was surrounded by corn crops that were either fully matured, pre-mature, or withered. Within this environment, participants had to respond to the continually increasing hunger of their digital avatar. As previously stated, this was achieved by collecting resources and then utilizing them for their avatar to consume. This process effectively prevented the avatar from starvation, at least temporarily. Moreover, participants were directed to a light switch that was powered by a battery

bank that generated electricity for overhead lighting. They were shown the finite amount of remaining power, along with how to turn it on and off.

After the treatment grouped watched the tutorial and completed the main objective, or the control group finished watching the tutorial, participants were given a post-test survey on their attitudes, feelings, and behavioral intentions regarding energy conservation. It lasted for five minutes. This post-test contained the same survey items as the pre-test, but also gauged their personal satisfaction with the game. After seven days, they were issued a final survey that also contained the aforementioned survey items, along with additional probes to determine whether or not they felt it had an impact on them throughout the week. However, they were not required to provide satisfaction ratings because that was only relevant to the post-test.

Results

Incomplete surveys were omitted from data analysis. This also included incomplete follow-up surveys due to attrition. Cronbach alpha scores were computed to measure internal consistency and reliability between survey items. It was revealed to range between 0.852-0.866. Participants were asked about their pre-existing expertise with single-player video games and also with the video game used in this study as well (Table 1).

Assuming equal variance, there were no significant differences between the control group and the treatment group in terms of the experience with the video game presented to them. However, there was a significant difference between the treatment (M = 2.5, SD = 2.27) and control (M = 4.0, SD = 3.22) conditions; t (46) = -1.87, p = 0.02. This was in terms of their own self-measured video game expertise, meaning that the control group felt that they had more expertise with single-player video games than the treatment group.

A linear mixed model was conducted in order to identify significant differences for both the treatment (n = 25) and control (n = 23) conditions. It utilized a pairwise comparison of time intervals between a pre-test, post-test, and 7-day follow-up for each survey item, using the Bonferroni correction (Appendix E, Table E1 & E2). The results depicted statistically significant differences ($p < 0.05$) in both the treatment and control conditions over time, be it immediately after, or after seven days.

However, there were some discrepancies in the survey items. For example, some survey items did or did not appear to be statistically significant in one condition versus the other. Moreover, comparison of the survey items across time revealed a statistically significant difference between two of the time intervals, but also a non-significant difference between two other intervals when compared with the treatment and control group.

The following results summary is divided into two categories: attitudes regarding general questions and attitudes regarding questions specifically geared towards university student behavior. Additionally, data regarding participant responses to perception and behavior questions are provided.

Attitude Responses to General Questions

Survey data on attitudes towards general questions regarding the treatment group are provided in Table 2. Survey data on attitudes focused on general questions regarding the control group are provided in Table 3.

Attitudes pertaining to participants' frequency for thinking about energy conservation tactics were probed to measure differences in responses to pre-test & post-test, pre-test & 7-day follow-up, and post-test & 7-day follow-up surveys. Participants in the treatment group reported no significant differences over time $F(2,72) = 2.11$, $p = 0.13$, 95% CIs [-0.25, 0.29], [-2.29, 0.53], [-1.17, 1.65], respectively. Participants in the control group reported no significant differences over time $F(2,66) = 3.136$, $p = 0.05$, 95% CIs [-3.30, 0.09], [-3.04, 0.35], [-1.43, 1.96], respectively. This was evidence to suggest that, on average, the intervention did not affect participants' frequency for thinking about energy conservation tactics.

Attitudes pertaining to participants' desires to know the source of their energy usage were probed to measure differences in responses to pre-test & post-test, pre-test & 7-day follow-up, and post-test & 7-day follow-up surveys. Participants in the treatment group reported significant differences over time $F(2,72) = 3.66$, $p = 0.03$, 95% CIs [-3.24, -0.04], [-1.84, 1.36], [-0.204, 3.00], respectively. Participants in the control group reported no significant differences over time $F(2,66) = 2.06$, $p = 0.14$, 95% CIs [-2.648, 0.30], [-2.34, 0.60], [-1.17, 1.778], respectively. This was evidence to suggest that the intervention significantly affected participants' desires to know

the source of their energy usage, specifically between the pre-test and post-test with an observed mean difference of -1.64, $p = 0.04$, 95% CI [-3.24, -0.04], but did not significantly affect their desires in the control condition. Therefore, the evidence suggested that, on average, participants had more desire to know the source of their energy usage immediately after they played the game but did not retain this desire after seven days.

Attitudes pertaining to participants' desires for knowing the impact of participants' energy usage on the environment were probed to measure differences in responses to pre-test & post-test, pre-test & 7-day follow-up, and post-test & 7-day follow-up surveys. Participants in the treatment group reported no significant differences over time $F(2,72) = 0.093$, $p = 0.91$, 95% CIs [-1.58, 1.58], [-1.34, 1.82], [-1.34, 1.82], respectively. Participants in the control group reported no significant differences over time $F(2,66) = 2.73$, $p = 0.07$, 95% CIs [-2.41, 0.23], [-2.41, 0.23], [-1.32, 1.32], respectively. This was evidence to suggest that the intervention did not significantly affect participants' desires for knowing the impact of participants' energy usage on the environment.

Attitudes pertaining to participants' disposition that energy conservation is not practiced enough at the individual level were probed to measure differences in responses to pre-test & post-test, pre-test & 7-day follow-up, and post-test & 7-day follow-up surveys. Participants in the treatment group reported no significant differences over time $F(2,72) = 1.14$, $p = 0.33$, 95% CIs [-0.63, 2.0], [-1.35, 1.27], [-2.03, 0.59], respectively. Participants in the control group reported no significant differences over time $F(2,66) = 2.74$, $p = 0.07$, 95% Cis [-1.15, 1.58], [-2.36, 0.36], [-2.58, 0.15], respectively. This was evidence to suggest that the intervention did not significantly affect participants' disposition that energy conservations are not practiced enough at the individual level.

Attitudes pertaining to participants' willingness to encourage others to model their own conservation practices were probed to measure differences in responses to pre-test & post-test, pre-test & 7-day follow-up, and post-test & 7-day follow-up surveys. Participants in the treatment group reported significant differences over time $F(2,72) = 19.79$, $p < 0.01$, 95% CIs [-5.26, -2.26], [-2.70, 0.30],[1.06, 4.06], respectively. Participants in the control group reported significant differences over time $F(2,66) = 5.21$, $p = 0.01$, 95% CIs [-3.62, -0.47], [-2.31, 0.84], [-0.27, 2.88], respectively. This was evidence to suggest that the intervention did affect participants' willingness to encourage others to model their own conservation practices and also significantly affected their willingness to do so in the control condition, specifically between the pre-test and 7-day follow-up with an observed mean difference of -3.76, $p < 0.01$, 95% CI [-5.26, -2.26] and -2.04, $p = 0.01$, 95% CI [-3.62, -0.47], respectively. Therefore, the evidence suggested that, on average, participants had more willingness to encourage others to model their own conservation practices after seven days of watching the tutorial and playing the game, as well as only watching the tutorial, but not immediately after watching the tutorial.

Attitudes pertaining to participants' reasoning for conserving energy due to cost were probed to measure differences in responses to pre-test & post-test, pre-test & 7-day follow-up, and post-test & 7-day follow-up surveys. Participants in the treatment group reported significant differences over time $F(2,72) = 5.09$, $p = 0.01$, 95% CIs [-3.28, -0.40], [-2.04, 0.84], [-0.20, 2.69], respectively. Participants in the control group reported no significant differences over time $F(2,66) = 0.74$, $p = 0.48$, 95% CIs [-2.19, 1.32], [-2.62, 0.88], [-2.19, 1.32], respectively. This was evidence to suggest that the intervention did affect participants' reasoning to conserve energy due to cost, specifically between the pre-test and post-test with an observed mean difference of -1.84, $p = 0.01$, 95% CI [-3.28, -0.40], but did not affect participants' reasoning in

the control condition. Therefore, the evidence suggested that, on average, participants had felt more strongly that their reason for conserving energy was due to cost immediately after playing the game, but did not retain this effect after seven days.

Attitude Responses to Questions Tailored Towards University Student Behavior

Survey data on attitudes towards questions focused on university student behaviors for the treatment group are provided in Table 4. Survey data on attitudes focused on university student behaviors regarding the control group are provided in Table 5.

The importance of specific energy conservation behaviors tailored towards university students were probed to measure differences in responses to pre-test & post-test, pre-test & 7-day follow-up, and post-test & 7-day follow-up surveys. All survey items pertaining to the participants' response to the importance of these behaviors reported non-significant differences in both the treatment and control condition, except for one. The exception was on the importance of biking to commute in the control condition. Participants in the treatment group reported no significant differences over time $F(2,72) = 2.13$, $p = 0.13$, 95% CIs [-0.76, 0.84], [-1.36, 0.24], [-1.40, 0.20], respectively. Participants in the control group reported significant differences over time $F(2,66) = 3.84$, $p = 0.03$, 95% CIs [-1.21, 0.51], [-1.82, -0.10], [-1.47, 0.25], respectively. This was evidence to suggest that the intervention did not affect participants' disposition on the importance of biking to commute, but did so in the control condition, specifically between the pre-test and 7-day follow-up survey with an observed mean difference of –0.96, $p = 0.02$, 95% CI [-1.82, -0.10]. Therefore, the evidence suggested that, on average, participants thought that it was more important to bike in order to commute after seven days of solely watching the tutorial, but not immediately afterwards. Furthermore, playing the game did not affect this disposition.

Perception Responses to General Questions

Survey data on perceptions towards general questions regarding the treatment group are provided in Table 6. Survey data on perceptions focused on general questions regarding the control group are provided in Table 7.

Perceptions pertaining to participants' perceived capabilities to formulate energy conscious behavioral strategies were probed to measure differences in responses to pre-test & post-test, pre-test & 7-day follow-up, and post-test & 7-day follow-up surveys. Participants in the treatment group reported no significant differences over time $F(2,72) = 1.46$, $p = 0.24$, 95% CIs [-1.84, 0.83], [-2.24, 0.40], [-1.72, 0.92], respectively. Participants in the control group reported significant differences over time $F(2,66) = 4.42$, $p = 0.02$, 95% CIs [-2.46, 0.63], [-3.41, -0.33], [-2.50, 0.59], respectively. This was evidence to suggest that the intervention did not affect participants' perceived capabilities to formulate energy conscious behavioral strategies, but significantly affected their perceived capabilities to do so in the control condition, specifically between the pre-test and 7-day follow-up with an observed mean difference of -1.87, $p = 0.01$, 95% CI [-2.50, 0.59]. Therefore, the evidence suggested that, on average, participants had perceived to be more capable of formulating energy conscious behavioral strategies after seven days but did not perceive to be more capable immediately after viewing the tutorial, and without playing the game.

Perceptions pertaining to participant's viewpoint that awareness for energy conservation is not effective as behavioral action were probed to measure differences in responses to pre-test & post-test, pre-test & 7-day follow-up, and post-test & 7-day follow-up surveys. Participants in the treatment group reported no significant differences over time $F(2,72) = 0.57$, $p = 0.57$, 95% CIs [-0.99, 2.43], [-1.51, 1.91], [-2.23, 1.19], respectively. Participants in the control group

reported no significant differences over time $F(2,66) = 1.20$, $p = 0.31$, 95% CIs [-2.25, 1.21], [-2.8, 0.64], [-2.30, 1.16], respectively. This was evidence to suggest that the intervention did not affect participants' viewpoint that awareness for energy conservation is not effective as behavioral action.

Perceptions pertaining to participant's viewpoint that watching educational videos on energy conservation are tiring were probed to measure differences in responses to pre-test & post-test, pre-test & 7-day follow-up, and post-test & 7-day follow-up surveys. Participants in the treatment group reported no significant differences over time $F(2,72) = 0.90$, $p = 0.42$, 95% CIs [-2.32, 1.12], [-1.40, 2.04], [-0.80, 2.64], respectively. Participants in the control group reported no significant differences over time $F(2,66) = 0.15$, $p = 0.86$, 95% CIs [-2.0, 1.56], [-1.6, 1.95], [-1.38, 2.17], respectively. This was evidence to suggest that the intervention did not affect participants' viewpoint that watching educational videos on energy conservation are tiring.

Perceptions pertaining to participant's viewpoint that friends who practice energy conservation influence themselves to do the same were probed to measure differences in responses to pre-test & post-test, pre-test & 7-day follow-up, and post-test & 7-day follow-up surveys. Participants in the treatment group reported no significant differences over time $F(2,72) = 0.26$, $p = 0.77$, 95% CIs [-2.12, 1.16], [-1.88, 1.40], [-1.40, 1.88], respectively. Participants in the control group reported no significant differences over time $F(2,66) = 1.00$, $p = 0.37$, 95% CIs [-2.08, 0.60], [-1.91, 0.77], [-1.17, 1.51], respectively. This was evidence to suggest that the intervention did not affect participants' viewpoint that friends who practice energy conservation.

Behavioral Responses to General Questions

Survey data on behaviors towards general questions regarding the treatment group are provided in Table 8. Survey data on behaviors focused on general questions regarding the control group are provided in Table 9.

Behaviors pertaining to participants' actively seeking new ways to conserve energy were probed to measure differences in responses to pre-test & post-test, pre-test & 7-day follow-up, and post-test & 7-day follow-up surveys. Participants in the treatment group reported no significant differences over time $F(2,72) = 0.80$, $p = 0.01$, 95% CIs [-2.24, 0.72], [-1.84, 1.12], [-1.08, 1.88], respectively. Participants in the control group reported significant differences over time $F(2,66) = 4.44$, $p = 0.02$, 95% CIs [-3.315, -0.26], [-2.89, 0.18], [-1.10, 2.0], respectively. This was evidence to suggest that the intervention did not affect participants' behavioral activism towards seeking new ways to conserve energy, but significantly affected their activism in the control condition, specifically between the pre-test and post-test with an observed mean difference of -1.78, $p = 0.02$, 95% CI [-3.32, -0.25]. Therefore, the evidence suggested that, on average, participants had actively sought out more ways to conserve energy immediately after watching the tutorial, without playing the game, but did not retain this desire after seven days.

Behaviors pertaining to participants' typical performance for energy conservation practices, even if it is unpopular, were probed to measure differences in responses to pre-test & post-test, pre-test & 7-day follow-up, and post-test & 7-day follow-up surveys. Participants in the treatment group reported significant differences over time $F(2,72) = 4.68$, $p = 0.01$, 95% Cis[-3.53, -0.39], [-2.61, 0.53], [-0.65, 2.50], respectively. Participants in the control group reported no significant differences over time $F(2,66) = 1.76$, $p = 0.12$, 95% CIs [-2.53, 0.45], [-2.40, 0.58], [-1.36, 1.62], respectively. This was evidence to suggest that the intervention did

significantly affect participants' typical performance for energy conservation practices, even if it is unpopular, specifically between the pre-test and post-test with an observed mean difference of -1.96, $p = 0.01$, 95% CI [-3.53, -0.39], but did not significantly affect their typical performance in the control condition. Therefore, the evidence suggested that, on average, participants typically performed more energy conservation practices immediately after playing the game but did not retain this typical performance after seven days.

Behavioral Responses to Follow-Up Questions

Survey data on behaviors towards the seven-day follow-up questions regarding the treatment group are provided in Table 6. Survey data on behaviors focused on the seven-day follow-up questions regarding the control group are provided in Table 7.

A chi-square test of independence was performed to examine the relation between the treatment and control group in terms of their behavioral responses to a seven-day follow-up. The relation between these variables were not significant and is evidence to suggest that the intervention had no effect on their behaviors concerning energy conservation after seven days. It is also important to note that the degree of freedom used in this test was modified to match the sample size of the intervention condition with the control group.

Summary

In summary, there was a significant difference between self-reported pre-existing expertise with single-player video games between the treatment and control groups. Moreover, there were significant differences between self-reported attitudes, perceptions, and behaviors regarding energy conservation within the realm of sustainability. Energy conservation in response to resource depletion was the aspect of sustainability for this study. This was demonstrated with resources such as firewood from trees that could be wasted, if left burning, and electricity from lead batteries that could be wasted, if left on unnecessarily. These were representations of real-world encounters where resources could be improperly and sub-optimally consumed.

Within the treatment group, participants were asked if they would encourage others to model their energy conservation practices and revealed statistically significant differences in mean values between the pre-test & post-test, as well as the post-test & the seven-day follow-up, but not between the pre-test and seven-day follow-up. When asked if they needed to know where their energy was coming from, if they typically performed energy conservation practices even if it was unpopular, and if their main reason for conserving energy was to save money, responses revealed significant differences in mean values between the pre-test & post-test, but not between the post-test & seven-day follow-up, or the pre-test & seven-day follow-up. These results have been illustrated in Figure 3.

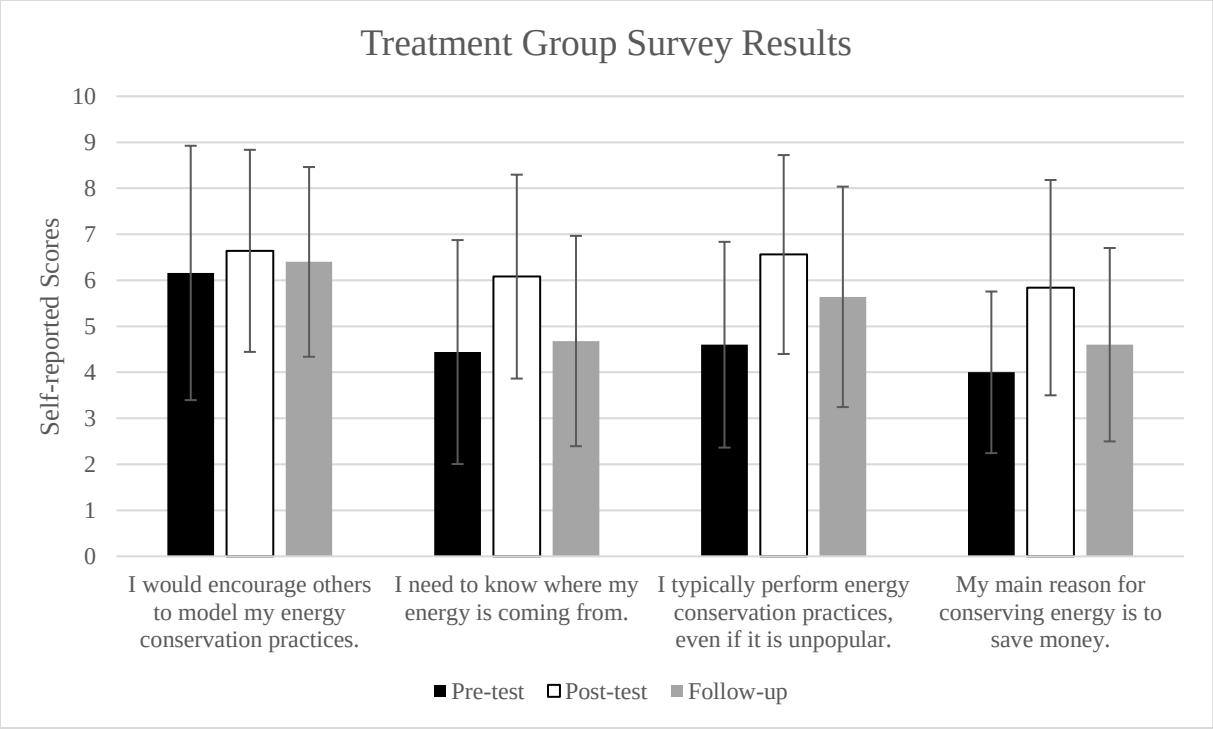


Figure 3: Self-reported mean and standard deviation scores for the treatment group from pre-test, post-test, and 7-day follow-up survey items.

Within the control condition, participants were asked if they actively sought out new ways to conserve energy and if they would encourage others to model their energy conservation practices. Responses revealed significant differences in mean values only between the pre-test & post-test. There were no significant differences in mean values between the post-test & seven-day follow-up, or the pre-test & seven-day follow-up. When participants were asked if they thought that they were capable of formulating energy conscious behavioral strategies, and how important they thought biking to commute was, responses revealed significant differences in mean values between the pre-test & seven-day follow-up, but not the pre-test & post-test or the post-test & seven-day follow. These results have been illustrated in Figure 4.

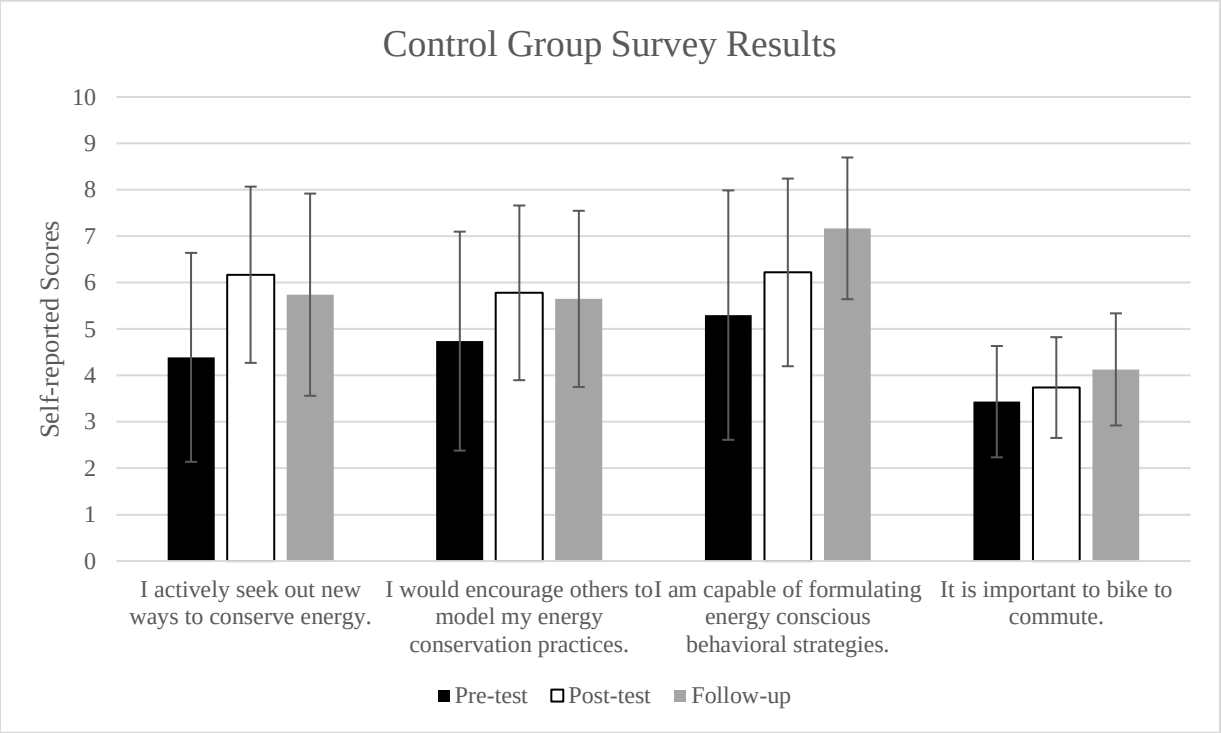


Figure 4: Self-reported mean and standard deviation scores for the control group from pre-test, post-test, and 7-day follow-up survey items.

Discussion

The hypotheses of this study were that over time, playing the game "7 Days to Die," a sandbox video game in a post-apocalyptic environment, would achieve significantly larger shifts in attitudes, perceptions, and behaviors related to sustainability, specifically energy conservation, than those who did not play. Their immediate and seven-day responses to survey items were pulled from existing literature (Barr et al., 2005; Chabalengula et al., 2012; DeWaters et al., 2013; Hara et al., 2015; Koballa, 1984; Lee et al., 2015; Ro et al., 2017), and then modified to fit within the scope of the target population, which consisted of university students at the undergraduate and graduate level. Cronbach alpha scores indicated reliability and internal consistency for observing the effects of these modalities with the survey items. Results varied, with the treatment demonstrating statistically significant results, as well as non-significant results, when compared to the control over time. However, there were statistically significant differences between time intervals for the control condition from some survey items that were not observed in the treatment condition. That is, for some survey items, there was a significant difference in the treatment condition, but not the control condition, and vice versa.

Section 1: Participants' pre-existing dispositions towards video games.

Table 1

Independent samples t-test of condition and survey items from the pre-test and post-test.

	Condition			
	Treatment	Control	*t*	[a]*df*
I am an expert at playing single-player video games.	2.5 (2.265)	4.0 (3.217)	*-1.868	46
Rate your experience.	4.46 (0.721)	4.13 (0.85)	1.465	46
The user interface made sense.	2.54 (2.519)	3.08 (3.078)	-0.667	46

The experience was challenging	6.71 (2.156)	7.88 (2.071)	-1.912	46

* $p < 0.05$

a. The degrees of freedom were modified to match the sample population size of the treatment group with the control group.

When participants were asked about their expertise with single player video games, there was a significant difference in responses between the control and treatment groups, specifically that the treatment group felt that they had less expertise. This could have affected results to survey items pertaining to their attitudes, perception, and behaviors concerning energy conservation, because familiarity may have played an important role in the experience presented to them.

There were no significant differences between the treatment and control conditions in terms of the user interface, but it generally received low scores and indicated that it was overwhelming to subjects. This was a very important finding that could have contributed to Some may have been more interested than others, and that begs the question of how immersive it was to them. Since the results indicated no significant differences between playing the game and watching the tutorial in terms of their rated experience, embodiment may have been affected by this which, according to Ahn et al. (2016), was a central theme to educating individuals through VR games. Because this was not a VR experience, it could have been a limiting factor in how immersive and impactful subjects viewed this experience. Moreover, the challenging aspect of the game was not significantly different from those who played or did not play the game, and so this could have been due to the tutorial explicitly indicating every particular task. Shaffer (2006), suggested that if participants were given less instructions and guidance, personal ownership

increases from problem-solving cognitive reasoning that individuals were required to achieve the main task.

Furthermore, the purpose of these items was to gauge the effectiveness of the video game on subjects when presented with a concept that may be unfamiliar to them, similar to how a video game can teach users about biochemistry and then practically apply learned concepts to create new insights within a competitive atmosphere (e.g., Cooper, 2014). Therefore, it may not have been as strong of an impact if this research was conducted with competition, but it could have also affected the results as well, since people who do not frequently practice energy conservation behaviors may have answered modestly in order to conveniently alter their current disposition. Perhaps if subjects continued to play the game more frequently, their disposition would have been observed to differ. Researchers have found that there was a cycle of expertise that followed repeated exposure (e.g., Gee, 2003).

Section 2 – Subsection 1: H1: Post-apocalyptic players did not have significantly larger shifts in attitudes than the control group in terms of frequency of thinking about energy conservation, desire for knowing the impact of their energy usage on the environment, and their disposition towards energy conservation practices not being practiced enough at the individual level.

Table 2

Pairwise comparison of attitude survey items towards energy conservation across time 1 (pre-test), time 2 (post-test), and time 3 (7-day follow-up) within the treatment group. Values are scored on a 10-point Likert scale.

Question	(I) Mean	(J) Mean	Mean Difference (I-J)	Std. Error	df	Sig.[c]	95% Confidence Interval for Difference[c]	
							Lower Bound	Upper Bound
Energy conservation tactics are frequently on my mind.	Pretest (5.43)	Posttest (6.55)	-1.12	0.575	72	0.166	-2.529	0.289
		7-day (6.330)	-0.88	0.575	72	0.39	-2.289	0.529
	Posttest (6.55)	Pretest (5.43)	1.12	0.575	72	0.166	-0.289	2.529
		7-day (6.330)	0.24	0.575	72	1	-1.169	1.649
	7-day (6.330)	Pretest (5.43)	0.88	0.575	72	0.39	-0.529	2.289
		Posttest (6.55)	-0.24	0.575	72	1	-1.649	1.169
I must know how my energy use contributes to the environment.	Pretest (5.426)	Posttest (5.426)	7.22E-16	0.644	72	1	-1.579	1.579
		7-day (5.176)	0.24	0.644	72	1	-1.339	1.819
	Posttest (5.426)	Pretest (5.426)	-7.22E-16	0.644	72	1	-1.579	1.579
		7-day (5.176)	0.24	0.644	72	1	-1.339	1.819
	7-day (5.176)	Pretest (5.426)	-0.24	0.644	72	1	-1.819	1.339
		Posttest (5.426)	-0.24	0.644	72	1	-1.819	1.339
Personal responsibility for conserving energy is not practiced enough individually.	Pretest (7.229)	Posttest (6.549)	0.68	0.536	72	0.627	-0.634	1.994
		7-day (7.197)	-0.04	0.536	72	1	-1.354	1.274
	Posttest (6.549)	Pretest (7.229)	-0.68	0.536	72	0.627	-1.994	0.634
		7-day (7.197)	-0.72	0.536	72	0.551	-2.034	0.594
	7-day (7.197)	Pretest (7.229)	0.04	0.536	72	1	-1.274	1.354

	Posttest (6.549)	0.72	0.536	72	0.551	-0.594	2.034

*p < 0.05, **p < 0.01, ***p < 0.001

a. Adjustment for multiple comparisons: Bonferroni ($\frac{\alpha}{3}$ = 0.0167). Values of 1 are truncated.

Table 3

Pairwise comparison of attitude survey items towards energy conservation across time 1 (pre-test), time 2 (post-test), and time 3 (7-day follow-up) within the control group. Values are scored on a 10-point Likert scale.

Question	(I) Mean	(J) Mean	Mean Difference (I-J)	Std. Error	df	Sig.[c]	95% Confidence Interval for Difference[c]	
							Lower Bound	Upper Bound
Energy conservation tactics are frequently on my mind.	Pretest (4.739)	Posttest (6.245)	-1.609	0.689	66	0.068	-3.302	0.085
		7-day (5.654)	-1.348	0.689	66	0.164	-3.041	0.346
	Posttest (6.245)	Pretest (4.739)	1.609	0.689	66	0.068	-0.085	3.302
		7-day (5.654)	0.261	0.689	66	1	-1.433	1.955
	7-day (5.654)	Pretest (4.739)	1.348	0.689	66	0.164	-0.346	3.041
		Posttest (6.245)	-0.261	0.689	66	1	-1.955	1.433
I must know how my energy use contributes to the environment.	Pretest (4.372)	Posttest (5.656)	-1.087	0.537	66	0.141	-2.407	0.233
		7-day (5.346)	-1.087	0.537	66	0.141	-2.407	0.233
	Posttest (5.656)	Pretest (4.372)	1.087	0.537	66	0.141	-0.233	2.407
		7-day (5.346)	1.39E-15	0.537	66	1	-1.32	1.32
	7-day (5.346)	Pretest (4.372)	1.087	0.537	66	0.141	-0.233	2.407
		Posttest (5.656)	-1.39E-15	0.537	66	1	-1.32	1.32
Personal responsibility for conserving energy is not practiced enough individually.	Pretest (6.861)	Posttest (6.748)	0.217	0.555	66	1	-1.146	1.581
		7-day (8.000)	-1	0.555	66	0.229	-2.364	0.364
	Posttest (6.748)	Pretest (6.861)	-0.217	0.555	66	1	-1.581	1.146
		7-day (8.000)	-1.217	0.555	66	0.096	-2.581	0.146
	7-day (8.000)	Pretest (6.861)	1	0.555	66	0.229	-0.364	2.364
		Posttest (6.748)	1.217	0.555	66	0.096	-0.146	2.581

*p < 0.05, **p < 0.01, ***p < 0.001

a. Adjustment for multiple comparisons: Bonferroni ($\frac{\alpha}{3}$ = 0.0167). Values of 1 are truncated.

Subjects did not differ in terms of frequency of thinking about energy conservation over time, desire for knowing the impact of their energy usage on the environment, and their disposition towards energy conservation practices not being practiced enough at the individual

level. This was observed for both the treatment and control conditions across time. What this means is that the game, nor the tutorial, had an impact on their attitudes pertaining to these inquisitions. However, it was possible that these were pre-existing attitudes that only served to reinforce their disposition, and thus explain why there were no differences observed. Therefore, the phrasing of these questions may not have been effective enough to tailor towards a change over time. When examining the recent literature concerning social sustainability, the example of equity relied upon recognition, redistribution, and participation (Dempsey, Bramley, Power, & Brown, 2011; Eizenberg & Jabareen, 2017). Therefore, this model would suggest that the scope of this study was not inclusive enough of these principles in the sense that, although recognition and redistribution were achieved, participation was only loosely incorporated. As such, the digital outcomes were not effectively comparable to the real, physical outcomes.

Section 2 – Subsection 2: H1: Post-apocalyptic players did have significantly larger shifts in attitudes than the control group in terms of the need to know where their energy is coming from.

Table 4

Pairwise comparison of attitude survey items towards energy conservation across time 1 (pre-test), time 2 (post-test), and time 3 (7-day follow-up) within the treatment group. Values are scored on a 10-point Likert scale.

Question	(I) Mean	(J) Mean	Mean Difference (I-J)	Std. Error	df	Sig.[c]	95% Confidence Interval for Difference[c]	
							Lower Bound	Upper Bound
I need to know where my energy is coming from.	Pretest (4.463)	Posttest (6.103)	-1.640*	0.654	72	0.043	-3.244	-0.036
		7-day (4.695)	-0.24	0.654	72	1	-1.844	1.364
	Posttest (6.103)	Pretest (4.463)	1.640*	0.654	72	0.043	0.036	3.244
		7-day (4.695)	1.4	0.654	72	0.107	-0.204	3.004
	7-day (4.695)	Pretest (4.463)	0.24	0.654	72	1	-1.364	1.844

		Posttest (6.103)	-1.4	0.654	72	0.107	-3.004	0.204

*p < 0.05, **p < 0.01, ***p < 0.001

a. Adjustment for multiple comparisons: Bonferroni ($\frac{\alpha}{3}$ = 0.0167). Values of 1 are truncated.

Table 5

Pairwise comparison of attitude survey items towards energy conservation across time 1 (pre-test), time 2 (post-test), and time 3 (7-day follow-up) within the control group. Values are scored on a 10-point Likert scale.

Question	(I) Mean	(J) Mean	Mean Difference (I-J)	Std. Error	df	Sig.[c]	95% Confidence Interval for Difference[c]	
							Lower Bound	Upper Bound
I need to know where my energy is coming from.	Pretest (4.563)	Posttest (5.760)	-1.174	0.6	66	0.164	-2.648	0.3
		7-day (5.231)	-0.87	0.6	66	0.456	-2.343	0.604
	Posttest (5.760)	Pretest (4.563)	1.174	0.6	66	0.164	-0.3	2.648
		7-day (5.231)	0.304	0.6	66	1	-1.169	1.778
	7-day (5.231)	Pretest (4.563)	0.87	0.6	66	0.456	-0.604	2.343
		Posttest (5.760)	-0.304	0.6	66	1	-1.778	1.169

*p < 0.05, **p < 0.01, ***p < 0.001

a. Adjustment for multiple comparisons: Bonferroni ($\frac{\alpha}{3}$ = 0.0167). Values of 1 are truncated.

Participants were more eager to know the source of their energy usage immediately after playing the game, but did not retain this desire after seven days. This was an indicator that the virtual resources they consumed transferred into an interest in the physical resources they consumed in real life, but only temporarily. In a related study, Chang et al. (2016) placed participants in a scenario where they were given feedback on how much energy their heating consumed in their hotel room. Because of this feedback mechanism, it provided subjects with information that allowed their cognitive reasoning to quantitate and then decide on how to proceed with their energy usage. This study and the research described here were similar in terms of a digital presentation for consumed resources, but differed in the sense that one was virtual and the other was real. Therefore, the observed differences seemed to support the conjecture that

participants' interests were affected after being presented with feedback from the source of their energy. However, since this did not persist after seven days, there was evidence that suggested it was only effective for the short-term, and not long-term.

Section 2 – Subsection 3: H1: Post-apocalyptic players and the control group did have significantly larger shifts in attitudes in terms of encouraging others to model their own conservation practices.

Table 6

Pairwise comparison of attitude survey items towards energy conservation across time 1 (pre-test), time 2 (post-test), and time 3 (7-day follow-up) within the treatment group. Values are scored on a 10-point Likert scale.

Question	(I) Mean	(J) Mean	Mean Difference (I-J)	Std. Error	df	Sig.[c]	95% Confidence Interval for Difference[c]	
							Lower Bound	Upper Bound
I would encourage others to model my conservation practices.	Pretest (4.067)	Posttest (7.827)	-3.760*	0.611	72	0	-5.257	-2.263
		7-day (5.219)	-1.2	0.611	72	0.16	-2.697	0.297
	Posttest (7.827)	Pretest (4.067)	3.760*	0.611	72	0	2.263	5.257
		7-day (5.219)	2.560*	0.611	72	0	1.063	4.057
	7-day (5.219)	Pretest (4.067)	1.2	0.611	72	0.16	-0.297	2.697
		Posttest (7.827)	-2.560*	0.611	72	0	-4.057	-1.063

*p < 0.05, **p < 0.01, ***p < 0.001

a. Adjustment for multiple comparisons: Bonferroni ($\frac{\alpha}{3}$ = 0.0167). Values of 1 are truncated.

Table 7

Pairwise comparison of attitude survey items towards energy conservation across time 1 (pre-test), time 2 (post-test), and time 3 (7-day follow-up) within the control group. Values are scored on a 10-point Likert scale.

Question	(I) Mean	(J) Mean	Mean Difference (I-J)	Std. Error	df	Sig.[c]	95% Confidence Interval for Difference[c]	
							Lower Bound	Upper Bound
I would encourage others to model my conservation practices.	Pretest (4.700)	Posttest (6.958)	-2.043*	0.641	66	0.007	-3.618	-0.469
		7-day (5.308)	-0.739	0.641	66	0.759	-2.314	0.835
	Posttest (6.958)	Pretest (4.700)	2.043*	0.641	66	0.007	0.469	3.618
		7-day (5.308)	1.304	0.641	66	0.138	-0.27	2.879
	7-day (5.308)	Pretest (4.700)	0.739	0.641	66	0.759	-0.835	2.314

		Posttest (6.958)	-1.304	0.641	66	0.138	-2.879	0.27

*p < 0.05, **p < 0.01, ***p < 0.001

a. Adjustment for multiple comparisons: Bonferroni ($\frac{\alpha}{3}$ = 0.0167). Values of 1 are truncated.

Among subjects, their willingness to encourage others to model their own conservation practices significantly increased in both the treatment and control conditions. Therefore, it was an indication that being presented with information and a task that was explicitly tailored towards energy consumption gave them the opportunity to share their experience over a conversation with their peers. Although it was not observed to significantly differ immediately, participants reported mentioning this study to their peers afterwards, and explained the significant findings for both conditions. This related Magis' (2010) concept of community resilience within the realm of social sustainability, where it highlighted the critical component of community members actively collecting and strategically engaging in social, cultural, political, natural, and built resources to respond with change. As such, the mere introduction of energy conservation provided subjects with an opportunity to engage in collecting and sharing this experience with others as a social resource after strategically engaging actively or passively in building a digital product.

Section 2 – Subsection 4: H1: Post-apocalyptic players did have significantly larger shifts in attitudes than the control group in terms of their main reason for conserving was to save money.

Table 8

Pairwise comparison of attitude survey items towards energy conservation across time 1 (pre-test), time 2 (post-test), and time 3 (7-day follow-up) within the treatment group. Values are scored on a 10-point Likert scale.

Question	(I) Mean	(J) Mean	Mean Difference (I-J)	Std. Error	df	Sig.[c]	95% Confidence Interval for Difference[c]	
							Lower Bound	Upper Bound

My main reason for conserving energy is to save money.	Pretest (6.190)	Posttest (6.670)	-1.840*	0.588	72	0.008	-3.282	-0.398
		7-day (6.364)	-0.6	0.588	72	0.933	-2.042	0.842
	Posttest (6.670)	Pretest (6.190)	1.840*	0.588	72	0.008	0.398	3.282
		7-day (6.364)	1.24	0.588	72	0.115	-0.202	2.682
	7-day (6.364)	Pretest (6.190)	0.6	0.588	72	0.933	-0.842	2.042
		Posttest (6.670)	-1.24	0.588	72	0.115	-2.682	0.202

*p < 0.05, **p < 0.01, ***p < 0.001

a. Adjustment for multiple comparisons: Bonferroni ($\frac{\alpha}{3}$ = 0.0167). Values of 1 are truncated.

Table 9

Pairwise comparison of attitude survey items towards energy conservation across time 1 (pre-test), time 2 (post-test), and time 3 (7-day follow-up) within the control group. Values are scored on a 10-point Likert scale.

Question	(I) Mean	(J) Mean	Mean Difference (I-J)	Std. Error	df	Sig.[c]	95% Confidence Interval for Difference[c]	
							Lower Bound	Upper Bound
My main reason for conserving energy is to save money.	Pretest (6.114)	Posttest (6.843)	-0.435	0.714	66	1	-2.188	1.319
		7-day (6.577)	-0.87	0.714	66	0.683	-2.623	0.884
	Posttest (6.843)	Pretest (6.114)	0.435	0.714	66	1	-1.319	2.188
		7-day (6.577)	-0.435	0.714	66	1	-2.188	1.319
	7-day (6.577)	Pretest (6.114)	0.87	0.714	66	0.683	-0.884	2.623
		Posttest (6.843)	0.435	0.714	66	1	-1.319	2.188

*p < 0.05, **p < 0.01, ***p < 0.001

a. Adjustment for multiple comparisons: Bonferroni ($\frac{\alpha}{3}$ = 0.0167). Values of 1 are truncated.

Participants believed more strongly that monetary costs were the main reason for conserving energy within the treatment condition, but not in the control condition, over time. The significant impact occurred immediately after playing the game. However, this effect did not last after seven days. What one could postulate, given the evidence, was that being presented with a full breakdown of required resources gave participants an accurate, holistic indication of the

costs associated with consuming them to achieve a goal. Furthermore, the experience of collecting and utilizing these resources themselves was the critical component that would explain the difference between the treatment and control conditions.

Therefore, until one actively executed a task to completion and witnessed the result first-hand, their reasoning for energy conservation would not differ from those who passively observed a third-party do the same. It was conceivable that the participants were better able to understand the true cost of time and labor required. As such, this could explain why money seemed to be a stronger influence on their main reasoning for conserving energy. Perhaps reallocation of cognitive resources towards an executive decision-making task was an opportunity to achieve creative outlooks that manifested themselves as attitudes towards money being their main reason to conserve energy. Since the control condition did not have to do this, it was understandable why their responses did not differ over time. A concept called avoidance motivation by Roskes et al. (2013), denoted higher depletion of cognitive resources and was associated with higher levels of creativity related to energy conservation strategies, which may be relatable to energy conservation strategies within this research. The results indicated that avoidance motivation led to heightened recruitment of cognitive resources and control. The treatment condition demanded performance, which could have affected their self-evaluation that money, was their main reasoning for conserving energy. Simply put, they were more aware of the mental effort required to perform energy conservation behaviors than the ones who did not have to perform and determined that money was more important than their cognitive abilities.

The treatment group reported no significant differences to their baseline responses after seven days, which could be the result of familiarity. Being acquainted with a task allowed participants to re-evaluate their attitudes. Therefore, the impact associated with the cost of time

and labor would not last after they were aware of the fact that they would not have to complete this task at another time, while money was something that remained salient to them at all times.

Section 3 – Subsection 1: H2: Post-apocalyptic players did not have significantly larger shifts in perceptions than the control group when asked if awareness for energy conservation for energy conservation was not effective enough as behavioral action, that watching education videos on energy conservation were tiring, and if friends who practice energy conservation influenced them to do the same.

Table 10

Pairwise comparison of perception survey items towards energy conservation across time 1 (pre-test), time 2 (post-test), and time 3 (7-day follow-up) within the treatment group. Values are scored on a 10-point Likert scale.

Question	(I) Mean	(J) Mean	Mean Difference (I-J)	Std. Error	df	Sig.[c]	95% Confidence Interval for Difference[c]	
							Lower Bound	Upper Bound
Awareness for energy conservation is not effective enough as behavioral action.	Pretest (6.855)	Posttest (6.135)	0.72	0.696	72	0.913	-0.986	2.426
		7-day (6.657)	0.2	0.696	72	1	-1.506	1.906
	Posttest (6.135)	Pretest (6.855)	-0.72	0.696	72	0.913	-2.426	0.986
		7-day (6.657)	-0.52	0.696	72	1	-2.226	1.186
	7-day (6.657)	Pretest (6.855)	-0.2	0.696	72	1	-1.906	1.506
		Posttest (6.135)	0.52	0.696	72	1	-1.186	2.226
Watching educational videos on energy conservation are tiring.	Pretest (5.235)	Posttest (5.835)	-0.6	0.7	72	1	-2.315	1.115
		7-day (4.827)	0.32	0.7	72	1	-1.395	2.035
	Posttest (5.835)	Pretest (5.235)	0.6	0.7	72	1	-1.115	2.315
		7-day (4.827)	0.92	0.7	72	0.578	-0.795	2.635
	7-day (4.827)	Pretest (5.235)	-0.32	0.7	72	1	-2.035	1.395
		Posttest (5.835)	-0.92	0.7	72	0.578	-2.635	0.795
Friends who practice energy conservation influence me to do the same.	Pretest (4.067)	Posttest (7.827)	-0.48	0.668	72	1	-2.116	1.156
		7-day (5.219)	-0.24	0.668	72	1	-1.876	1.396
	Posttest (7.827)	Pretest (4.067)	0.48	0.668	72	1	-1.156	2.116
		7-day (5.219)	0.24	0.668	72	1	-1.396	1.876
	7-day (5.219)	Pretest (4.067)	0.24	0.668	72	1	-1.396	1.876

		Posttest (7.827)	-0.24	0.668	72	1	-1.876	1.396

*p < 0.05, **p < 0.01, ***p < 0.001

a. Adjustment for multiple comparisons: Bonferroni ($\frac{\alpha}{3}$ = 0.0167). Values of 1 are truncated.

Table 11

Pairwise comparison of perception survey items towards energy conservation across time 1 (pre-test), time 2 (post-test), and time 3 (7-day follow-up) within the control group. Values are scored on a 10-point Likert scale.

Question	(I) Mean	(J) Mean	Mean Difference (I-J)	Std. Error	df	Sig.[c]	95% Confidence Interval for Difference[c]	
							Lower Bound	Upper Bound
Awareness for energy conservation is not effective enough as behavioral action.	Pretest (5.855)	Posttest (6.355)	-0.522	0.703	66	1	-2.25	1.206
		7-day (7.077)	-1.087	0.703	66	0.381	-2.815	0.641
	Posttest (6.355)	Pretest (5.855)	0.522	0.703	66	1	-1.206	2.25
		7-day (7.077)	-0.565	0.703	66	1	-2.293	1.163
	7-day (7.077)	Pretest (5.855)	1.087	0.703	66	0.381	-0.641	2.815
		Posttest (6.355)	0.565	0.703	66	1	-1.163	2.293
Watching educational videos on energy conservation are tiring.	Pretest (5.208)	Posttest (5.485)	-0.217	0.723	66	1	-1.993	1.558
		7-day (4.885)	0.174	0.723	66	1	-1.602	1.949
	Posttest (5.485)	Pretest (5.208)	0.217	0.723	66	1	-1.558	1.993
		7-day (4.885)	0.391	0.723	66	1	-1.384	2.167
	7-day (4.885)	Pretest (5.208)	-0.174	0.723	66	1	-1.949	1.602
		Posttest (5.485)	-0.391	0.723	66	1	-2.167	1.384
Friends who practice energy conservation influence me to do the same.	Pretest (4.700)	Posttest (6.958)	-0.739	0.545	66	0.54	-2.079	0.601
		7-day (5.308)	-0.565	0.545	66	0.911	-1.905	0.774
	Posttest (6.958)	Pretest (4.700)	0.739	0.545	66	0.54	-0.601	2.079
		7-day (5.308)	0.174	0.545	66	1	-1.166	1.514
	7-day (5.308)	Pretest (4.700)	0.565	0.545	66	0.911	-0.774	1.905
		Posttest (6.958)	-0.174	0.545	66	1	-1.514	1.166

*p < 0.05, **p < 0.01, ***p < 0.001

a. Adjustment for multiple comparisons: Bonferroni ($\frac{\alpha}{3}$ = 0.0167). Values of 1 are truncated.

The perceptions that participants had on their viewpoint that awareness for energy conservation was not effective as behavioral action, that watching educational videos on energy conservation was tiring, and that friends who practiced energy conservation played a role in influencing themselves to do the same did not significantly differ between the treatment and control condition over time. A study in the UK and Portugal assessed students on their perspective of information pertaining to energy conservation, which included the role that their academic institutions played on the matter, demonstrated low scores attributed to accessibility, performance, and awareness (Cotton et al., 2016). This could serve as an indicator that many academic institutions fall within the same purview of this poor initiative made by universities to incentivize students with energy conservation behaviors. However, this is not true in all cases, as evidenced by Desrochers and Mosher (2017), because there have been initiatives that go as far as evaluating informational and behavior change programs to increase students' self-reported energy conservation.

Section 3 – Subsection 2: H2: Post-apocalyptic players did not have significantly larger shifts in perceptions than the control group when asked about their perceived importance of many behavioral practices pertaining to energy conservation.

Table 12

Pairwise comparison of perception survey items towards energy conservation across time 1 (pre-test), time 2 (post-test), and time 3 (7-day follow-up) within the treatment group. Values are scored on a 5-star rating scale.

Question	(I) Mean	(J) Mean	Mean Difference (I-J)	Std. Error	df	Sig.[c]	95% Confidence Interval for Difference[c]	
							Lower Bound	Upper Bound
Turning appliances off at the wall.	Pretest (3.598)	Posttest (3.998)	-0.4	0.308	72	0.596	-1.156	0.356
		7-day (4.228)	-0.62	0.308	72	0.144	-1.376	0.136
	Posttest (3.998)	Pretest (3.598)	0.4	0.308	72	0.596	-0.356	1.156

		7-day (4.228)	-0.22	0.308	72	1	-0.976	0.536
	7-day (4.228)	Pretest (3.598)	0.62	0.308	72	0.144	-0.136	1.376
		Posttest (3.998)	0.22	0.308	72	1	-0.536	0.976
Washing hands in cold water.	Pretest (2.760)	Posttest (2.820)	-0.06	0.292	72	1	-0.776	0.656
		7-day (3.176)	-0.4	0.292	72	0.526	-1.116	0.316
	Posttest (2.820)	Pretest (2.760)	0.06	0.292	72	1	-0.656	0.776
		7-day (3.176)	-0.34	0.292	72	0.745	-1.056	0.376
	7-day (3.176)	Pretest (2.760)	0.4	0.292	72	0.526	-0.316	1.116
		Posttest (2.820)	0.34	0.292	72	0.745	-0.376	1.056
Rinsing the dishes in cold water.	Pretest (2.958)	Posttest (3.018)	-0.06	0.297	72	1	-0.788	0.668
		7-day (3.168)	-0.2	0.297	72	1	-0.928	0.528
	Posttest (3.018)	Pretest (2.958)	0.06	0.297	72	1	-0.668	0.788
		7-day (3.168)	-0.14	0.297	72	1	-0.868	0.588
	7-day (3.168)	Pretest (2.958)	0.2	0.297	72	1	-0.528	0.928
		Posttest (3.018)	0.14	0.297	72	1	-0.588	0.868
Reduce heating in unoccupied rooms.	Pretest (4.449)	Posttest (4.469)	-0.02	0.188	72	1	-0.481	0.441
		7-day (4.441)	5.00E-15	0.188	72	1	-0.461	0.461
	Posttest (4.469)	Pretest (4.449)	0.02	0.188	72	1	-0.441	0.481
		7-day (4.441)	0.02	0.188	72	1	-0.441	0.481
	7-day (4.441)	Pretest (4.449)	-5.00E-15	0.188	72	1	-0.461	0.461
		Posttest (4.469)	-0.02	0.188	72	1	-0.481	0.441
Reducing hot water temperature.	Pretest (3.152)	Posttest (3.612)	-0.46	0.271	72	0.283	-1.125	0.205
		7-day (3.598)	-0.46	0.271	72	0.283	-1.125	0.205
	Posttest (3.612)	Pretest (3.152)	0.46	0.271	72	0.283	-0.205	1.125
		7-day (3.598)	-7.53E-15	0.271	72	1	-0.665	0.665
	7-day (3.598)	Pretest (3.152)	0.46	0.271	72	0.283	-0.205	1.125
		Posttest (3.612)	7.53E-15	0.271	72	1	-0.665	0.665
Wait for a full load before using the washing machine.	Pretest (4.271)	Posttest (4.431)	-0.16	0.206	72	1	-0.665	0.345
		7-day (4.484)	-0.22	0.206	72	0.866	-0.725	0.285

	Posttest (4.431)	Pretest (4.271)	0.16	0.206	72	1	-0.345	0.665
		7-day (4.484)	-0.06	0.206	72	1	-0.565	0.445
	7-day (4.484)	Pretest (4.271)	0.22	0.206	72	0.866	-0.285	0.725
		Posttest (4.431)	0.06	0.206	72	1	-0.445	0.565
Taking shorter showers.	Pretest (3.956)	Posttest (3.956)	-1.50E-15	0.326	72	1	-0.799	0.799
		7-day (3.796)	0.08	0.326	72	1	-0.719	0.879
	Posttest (3.956)	Pretest (3.956)	1.50E-15	0.326	72	1	-0.799	0.799
		7-day (3.796)	0.08	0.326	72	1	-0.719	0.879
	7-day (3.796)	Pretest (3.956)	-0.08	0.326	72	1	-0.879	0.719
		Posttest (3.956)	-0.08	0.326	72	1	-0.879	0.719
Doing dishes by hand.	Pretest (3.972)	Posttest (3.952)	0.02	0.31	72	1	-0.74	0.78
		7-day (3.761)	0.18	0.31	72	1	-0.58	0.94
	Posttest (3.952)	Pretest (3.972)	-0.02	0.31	72	1	-0.78	0.74
		7-day (3.761)	0.16	0.31	72	1	-0.6	0.92
	7-day (3.761)	Pretest (3.972)	-0.18	0.31	72	1	-0.94	0.58
		Posttest (3.952)	-0.16	0.31	72	1	-0.92	0.6

*p < 0.05, **p < 0.01, ***p < 0.001

a. Adjustment for multiple comparisons: Bonferroni ($\frac{\alpha}{3}$ = 0.0167). Values of 1 are truncated.

Table 13

Pairwise comparison of perception survey items towards energy conservation across time 1 (pre-test), time 2 (post-test), and time 3 (7-day follow-up) within the control group. Values are scored on a 5-star rating scale.

Question	(I) Mean	(J) Mean	Mean Difference (I-J)	Std. Error	df	Sig.[c]	95% Confidence Interval for Difference[c]	
							Lower Bound	Upper Bound
Turning appliances off at the wall.	Pretest (3.915)	Posttest (4.108)	-0.217	0.287	66	1	-0.921	0.487
		7-day (4.231)	-0.413	0.287	66	0.463	-1.117	0.291
	Posttest (4.108)	Pretest (3.915)	0.217	0.287	66	1	-0.487	0.921
		7-day (4.231)	-0.196	0.287	66	1	-0.9	0.508
	7-day (4.231)	Pretest (3.915)	0.413	0.287	66	0.463	-0.291	1.117

		Posttest (4.108)	0.196	0.287	66	1	-0.508	0.9
Washing hands in cold water.	Pretest (2.979)	Posttest (3.130)	-0.217	0.383	66	1	-1.158	0.723
		7-day (3.308)	-0.522	0.383	66	0.533	-1.463	0.419
	Posttest (3.130)	Pretest (2.979)	0.217	0.383	66	1	-0.723	1.158
		7-day (3.308)	-0.304	0.383	66	1	-1.245	0.636
	7-day (3.308)	Pretest (2.979)	0.522	0.383	66	0.533	-0.419	1.463
		Posttest (3.130)	0.304	0.383	66	1	-0.636	1.245
Rinsing the dishes in cold water.	Pretest (2.745)	Posttest (3.043)	-0.37	0.366	66	0.948	-1.268	0.529
		7-day (3.346)	-0.696	0.366	66	0.184	-1.594	0.203
	Posttest (3.043)	Pretest (2.745)	0.37	0.366	66	0.948	-0.529	1.268
		7-day (3.346)	-0.326	0.366	66	1	-1.224	0.572
	7-day (3.346)	Pretest (2.745)	0.696	0.366	66	0.184	-0.203	1.594
		Posttest (3.043)	0.326	0.366	66	1	-0.572	1.224
Reduce heating in unoccupied rooms.	Pretest (4.209)	Posttest (4.536)	-0.348	0.282	66	0.664	-1.04	0.344
		7-day (4.250)	-0.065	0.282	66	1	-0.757	0.627
	Posttest (4.536)	Pretest (4.209)	0.348	0.282	66	0.664	-0.344	1.04
		7-day (4.250)	0.283	0.282	66	0.959	-0.41	0.975
	7-day (4.250)	Pretest (4.209)	0.065	0.282	66	1	-0.627	0.757
		Posttest (4.536)	-0.283	0.282	66	0.959	-0.975	0.41
Reducing hot water temperature.	Pretest (2.973)	Posttest (3.451)	-0.543	0.353	66	0.385	-1.411	0.324
		7-day (3.577)	-0.717	0.353	66	0.139	-1.585	0.15
	Posttest (3.451)	Pretest (2.973)	0.543	0.353	66	0.385	-0.324	1.411
		7-day (3.577)	-0.174	0.353	66	1	-1.041	0.693
	7-day (3.577)	Pretest (2.973)	0.717	0.353	66	0.139	-0.15	1.585
		Posttest (3.451)	0.174	0.353	66	1	-0.693	1.041
Wait for a full load before using the washing machine.	Pretest (4.278)	Posttest (4.430)	-0.174	0.252	66	1	-0.792	0.444
		7-day (4.462)	-0.283	0.252	66	0.796	-0.901	0.335
	Posttest (4.430)	Pretest (4.278)	0.174	0.252	66	1	-0.444	0.792
		7-day (4.462)	-0.109	0.252	66	1	-0.727	0.509

	7-day (4.462)	Pretest (4.278)	0.283	0.252	66	0.796	-0.335	0.901
		Posttest (4.430)	0.109	0.252	66	1	-0.509	0.727
Taking shorter showers.	Pretest (3.392)	Posttest (3.639)	-0.304	0.344	66	1	-1.149	0.54
		7-day (3.720)	-0.696	0.344	66	0.141	-1.54	0.149
	Posttest (3.639)	Pretest (3.392)	0.304	0.344	66	1	-0.54	1.149
		7-day (3.720)	-0.391	0.344	66	0.777	-1.236	0.453
	7-day (3.720)	Pretest (3.392)	0.696	0.344	66	0.141	-0.149	1.54
		Posttest (3.639)	0.391	0.344	66	0.777	-0.453	1.236
Doing dishes by hand.	Pretest (3.867)	Posttest (4.066)	-0.261	0.337	66	1	-1.088	0.567
		7-day (4.000)	0.152	0.337	66	1	-0.675	0.98
	Posttest (4.066)	Pretest (3.867)	0.261	0.337	66	1	-0.567	1.088
		7-day (4.000)	0.413	0.337	66	0.674	-0.414	1.241
	7-day (4.000)	Pretest (3.867)	-0.152	0.337	66	1	-0.98	0.675
		Posttest (4.066)	-0.413	0.337	66	0.674	-1.241	0.414

*p < 0.05, **p < 0.01, ***p < 0.001

a. Adjustment for multiple comparisons: Bonferroni ($\frac{\alpha}{3}$ = 0.0167). Values of 1 are truncated.

Furthermore, when asked about the perceived importance of many behavioral practices pertaining to energy conservation, a strikingly large majority of them did not significantly differ either. This included practices such as turning appliances off at the wall, washing hands in cold water, taking shorter showers, and more (Table 4 & 5). This observed result was similar to a study by Desrochers and Mosher (2017), where self-reported time in hours for turning off devices after a pseudo-contract for green behavior was not significantly different from a control. An explanation of these findings was to consider the pre-existing disposition of participants partaking in these behavioral practices already. This would explain why the intervention did not affect their scores over time, primarily because they either did or did not already perform these behaviors. Moreover, one could argue that testing effects were observed because the same set of

questions were administered in the pre-test, post-test, and seven-day follow-up. However, all of these behavioral practices related to saving money, since heating is one of the primary costs associated with energy usage. Perhaps if the intervention was tailored more towards presenting real-life examples of these behavioral practices, along with the true costs associated with both participation and non-participation in comparison, significant differences would be observed. This postulation is similar to the learning cycle research by Dorji et al., (2015) involving educational computer games for improving students' learning and awareness in electric energy consumption and conservation, where detailed data in watts were presented to participants for household items when consuming energy. Therefore, the evidence suggests that an abstraction, such as the treatment, was not as effective as real examples of household items in affecting their perception of behavioral practices pertaining to energy conservation.

Section 3 – Subsection 3: H2: Control group did have significantly larger shifts in perceptions than post-apocalyptic players when asked about their perceived capability of formulating energy conscious behavioral strategies and the importance of many behavioral practices pertaining to energy conservation.

Table 14

Pairwise comparison of perception survey items towards energy conservation across time 1 (pre-test), time 2 (post-test), and time 3 (7-day follow-up) within the treatment group. Values are scored on a 10-point Likert scale.

Question	(I) Mean	(J) Mean	Mean Difference (I-J)	Std. Error	df	Sig.[c]	95% Confidence Interval for Difference[c]	
							Lower Bound	Upper Bound
I am capable of formulating energy conscious behavioral strategies.	Pretest (6.010)	Posttest (6.530)	-0.52	0.54	72	1	-1.843	0.803
		7-day (6.924)	-0.92	0.54	72	0.278	-2.243	0.403
	Posttest (6.530)	Pretest (6.010)	0.52	0.54	72	1	-0.803	1.843
		7-day (6.924)	-0.4	0.54	72	1	-1.723	0.923

	7-day (6.924)	Pretest (6.010)	0.92	0.54	72	0.278	-0.403	2.243
		Posttest (6.530)	0.4	0.54	72	1	-0.923	1.723

*p < 0.05, **p < 0.01, ***p < 0.001

a. Adjustment for multiple comparisons: Bonferroni ($\frac{\alpha}{3}$ = 0.0167). Values of 1 are truncated.

Table 15

Pairwise comparison of perception survey items towards energy conservation across time 1 (pre-test), time 2 (post-test), and time 3 (7-day follow-up) within the control group. Values are scored on a 10-point Likert scale.

Question	(I) Mean	(J) Mean	Mean Difference (I-J)	Std. Error	df	Sig.[c]	95% Confidence Interval for Difference[c]	
							Lower Bound	Upper Bound
I am capable of formulating energy conscious behavioral strategies.	Pretest (5.229)	Posttest (6.195)	-0.913	0.629	66	0.454	-2.458	0.632
		7-day (7.115)	-1.870*	0.629	66	0.012	-3.414	-0.325
	Posttest (6.195)	Pretest (5.229)	0.913	0.629	66	0.454	-0.632	2.458
		7-day (7.115)	-0.957	0.629	66	0.399	-2.501	0.588
	7-day (7.115)	Pretest (5.229)	1.870*	0.629	66	0.012	0.325	3.414
		Posttest (6.195)	0.957	0.629	66	0.399	-0.588	2.501

*p < 0.05, **p < 0.01, ***p < 0.001

a. Adjustment for multiple comparisons: Bonferroni ($\frac{\alpha}{3}$ = 0.0167). Values of 1 are truncated.

Table 16

Pairwise comparison of perception survey items towards energy conservation across time 1 (pre-test), time 2 (post-test), and time 3 (7-day follow-up) within the treatment group. Values are scored on a 5-star rating scale.

Question	(I) Mean	(J) Mean	Mean Difference (I-J)	Std. Error	df	Sig.[c]	95% Confidence Interval for Difference[c]	
							Lower Bound	Upper Bound
Biking to commute.	Pretest (3.191)	Posttest (3.151)	0.04	0.325	72	1	-0.756	0.836
		7-day (3.277)	-0.56	0.325	72	0.267	-1.356	0.236
	Posttest (3.151)	Pretest (3.191)	-0.04	0.325	72	1	-0.836	0.756
		7-day (3.277)	-0.6	0.325	72	0.206	-1.396	0.196
	7-day (3.277)	Pretest (3.191)	0.56	0.325	72	0.267	-0.236	1.356

		Posttest (3.151)	0.6	0.325	72	0.206	-0.196	1.396

*p < 0.05, **p < 0.01, ***p < 0.001

a. Adjustment for multiple comparisons: Bonferroni ($\frac{\alpha}{3}$ = 0.0167). Values of 1 are truncated.

Table 17

Pairwise comparison of perception survey items towards energy conservation across time 1 (pre-test), time 2 (post-test), and time 3 (7-day follow-up) within the control group. Values are scored on a 5-star rating scale.

Question	(I) Mean	(J) Mean	Mean Difference (I-J)	Std. Error	df	Sig.[c]	95% Confidence Interval for Difference[c]	
							Lower Bound	Upper Bound
Biking to commute.	Pretest (3.166)	Posttest (3.440)	-0.348	0.349	66	0.969	-1.206	0.51
		7-day (3.788)	-.957*	0.349	66	0.024	-1.815	-0.098
	Posttest (3.440)	Pretest (3.166)	0.348	0.349	66	0.969	-0.51	1.206
		7-day (3.788)	-0.609	0.349	66	0.258	-1.467	0.25
	7-day (3.788)	Pretest (3.166)	.957*	0.349	66	0.024	0.098	1.815
		Posttest (3.440)	0.609	0.349	66	0.258	-0.25	1.467

*p < 0.05, **p < 0.01, ***p < 0.001

a. Adjustment for multiple comparisons: Bonferroni ($\frac{\alpha}{3}$ = 0.0167). Values of 1 are truncated.

However, two noticeable differences reported to be significant were within the control group, specifically on the importance of biking to commute and perceived capabilities to formulate energy conscious behavioral decisions. The evidence suggested that participants thought it was more important to bike in order to commute after seven days of only watching the tutorial, but not playing it. In addition, they thought that they were more capable of formulating energy conscious behavioral decisions. Playing the game did not result in significant differences within the treatment group. One possible explanation was maturation, specifically that participants undergoing naturally occurring changes over time affected the result of this probe. This required investigation of the sample population. The sample population from the treatment group consisted of participants with a larger age range than the control group. The control group

only consisted of undergraduate level students. The treatment group consisted of several graduate level students. And so, there was uncertainty as to whether or not this was the reason for the observed result. Maturation could be a salient factor.

Generally speaking, many undergraduates at Cornell live on campus or within walking distance. However, again generally, graduate students do not live in student dorms. Instead, they live in apartments or houses. The costs associated with the importance on behavioral practice survey items may be invisible to undergraduate students, and this is because the cost of living is not presented to them frequently, and with guaranteed accessibility. Graduate students who live in apartments or houses are given detailed data on their own energy consumption with a utility bill. They are also largely certain of their individual identities and set in their ways. The age of respondents, along with the number of family members in their household were shown to be statistically significant determinant factors of electricity consumption (Hara et al., 2015).

Section 4 – Subsection 1: H3: Control group did have significantly larger shifts in behaviors than post-apocalyptic players when asked if they actively sought out new ways to conserve energy.

Table 18

Pairwise comparison of perception survey items towards energy conservation across time 1 (pre-test), time 2 (post-test), and time 3 (7-day follow-up) within the treatment group. Values are scored on a 10-point Likert scale.

Question	(I) Mean	(J) Mean	Mean Difference (I-J)	Std. Error	df	Sig.[c]	95% Confidence Interval for Difference[c]	
							Lower Bound	Upper Bound
I actively seek new ways to conserve energy.	Pretest (5.485)	Posttest (6.245)	-0.76	0.602	72	0.633	-2.236	0.716
		7-day (5.845)	-0.36	0.602	72	1	-1.836	1.116
	Posttest (6.245)	Pretest (5.485)	0.76	0.602	72	0.633	-0.716	2.236
		7-day (5.845)	0.4	0.602	72	1	-1.076	1.876
	7-day (5.845)	Pretest (5.485)	0.36	0.602	72	1	-1.116	1.836
		Posttest (6.245)	-0.4	0.602	72	1	-1.876	1.076

*p < 0.05, **p < 0.01, ***p < 0.001

a. Adjustment for multiple comparisons: Bonferroni ($\frac{\alpha}{3}$ = 0.0167). Values of 1 are truncated.

Table 19

Pairwise comparison of perception survey items towards energy conservation across time 1 (pre-test), time 2 (post-test), and time 3 (7-day follow-up) within the control group. Values are scored on a 10-point Likert scale.

Question	(I) Mean	(J) Mean	Mean Difference (I-J)	Std. Error	df	Sig.[c]	95% Confidence Interval for Difference[c]	
							Lower Bound	Upper Bound
I actively seek new ways to conserve energy.	Pretest (4.390)	Posttest (6.098)	-1.783*	0.624	66	0.017	-3.315	-0.251
		7-day (5.462)	-1.348	0.624	66	0.103	-2.88	0.184
	Posttest (6.098)	Pretest (4.390)	1.783*	0.624	66	0.017	0.251	3.315
		7-day (5.462)	0.435	0.624	66	1	-1.097	1.967
	7-day (5.462)	Pretest (4.390)	1.348	0.624	66	0.103	-0.184	2.88

		Posttest (6.098)	-0.435	0.624	66	1	-1.967	1.097

*p < 0.05, **p < 0.01, ***p < 0.001

a. Adjustment for multiple comparisons: Bonferroni ($\frac{\alpha}{3}$ = 0.0167). Values of 1 are truncated.

Responses regarding actively seeking new ways to conserve energy were observed to significantly differ within the control condition immediately after watching the tutorial, but this effect did not persist after seven days and the treatment did not demonstrate significant differences over time. This indicated that playing the game had no effect, but purely watching the tutorial was effective enough to shift behavioral responses from the control group, specifically an increase in self-reported activism to seeking new ways to conserve energy. This result runs contrary to the findings of other studies that suggested that learning was more effective when done proactively (Elenkov & Fileva, 2006; Okada, Kobuse, Takehara, & Manabe, 2016; Richert, Kleinjohann, & Murmann, 2006). However, the treatment group may have felt that they had already been actively seeking new ways to conserve energy, since they had just done so in a novel digital environment, and thus conclude with confirmation of their pre-existing activism.

Section 4 – Subsection 2: H3: Post-apocalyptic players did have significantly larger shifts in behaviors than the control group when asked if they typically performed energy conservation practices, even if it was unpopular.

Table 20

Pairwise comparison of perception survey items towards energy conservation across time 1 (pre-test), time 2 (post-test), and time 3 (7-day follow-up) within the treatment group. Values are scored on a 10-point Likert scale.

Question	(I) Mean	(J) Mean	Mean Difference (I-J)	Std. Error	df	Sig.[c]	95% Confidence Interval for Difference[c]	
							Lower Bound	Upper Bound
	Pretest (4.619)	Posttest (6.579)	-1.960*	0.641	72	0.009	-3.531	-0.389

I typically perform energy conservation practices, even if it is unpopular.		7-day (5.680)	-1.04	0.641	72	0.327	-2.611	0.531
	Posttest (6.579)	Pretest (4.619)	1.960*	0.641	72	0.009	0.389	3.531
		7-day (5.680)	0.92	0.641	72	0.467	-0.651	2.491
	7-day (5.680)	Pretest (4.619)	1.04	0.641	72	0.327	-0.531	2.611
		Posttest (6.579)	-0.92	0.641	72	0.467	-2.491	0.651

*p < 0.05, **p < 0.01, ***p < 0.001

a. Adjustment for multiple comparisons: Bonferroni ($\frac{\alpha}{3}$ = 0.0167). Values of 1 are truncated.

Table 21

Pairwise comparison of perception survey items towards energy conservation across time 1 (pre-test), time 2 (post-test), and time 3 (7-day follow-up) within the control group. Values are scored on a 10-point Likert scale.

Question	(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	df	Sig.[c]	95% Confidence Interval for Difference[c]	
							Lower Bound	Upper Bound
I typically perform energy conservation practices, even if it is unpopular.	Pretest (4.619)	Posttest (5.818)	-1.043	0.607	66	0.271	-2.534	0.447
		7-day (5.385)	-0.913	0.607	66	0.412	-2.404	0.578
	Posttest (5.818)	Pretest (4.619)	1.043	0.607	66	0.271	-0.447	2.534
		7-day (5.385)	0.13	0.607	66	1	-1.36	1.621
	7-day (5.385)	Pretest (4.619)	0.913	0.607	66	0.412	-0.578	2.404
		Posttest (5.818)	-0.13	0.607	66	1	-1.621	1.36

*p < 0.05, **p < 0.01, ***p < 0.001

a. Adjustment for multiple comparisons: Bonferroni ($\frac{\alpha}{3}$ = 0.0167). Values of 1 are truncated.

The treatment group reported higher scores to indicate that they typically performed energy conservation practices, even if it was unpopular, immediately after playing the game. This effect did not last after seven days. The control group did not report significant differences. The same line of reasoning for the significantly higher shift in behavioral responses towards actively seeking new ways to conserving energy applied within this scope as well. Therefore, the evidence suggested that the intervention allowed participants to confirm their own accuracy

about themselves in response to an activity that demanded practical usage of their personal mental frameworks related to energy conservation. The mental model that the treatment group relied upon for the intervention task may have been the same model that affected their typical performance of energy conservation practices, which was evidenced by the findings of this survey item.

Section 5: H2 & H3: Post-apocalyptic players did not have significantly larger shifts in perceptions and behaviors than the control group when asked after seven days.

Table 22

Comparison of condition and survey items from the 7-day follow-up

Questions	Overall sample	Yes (expected)	No (expected)	Yes (count)	No (count)	Chi square tests of independence
Ever since you participated in this study. Have you thought about anything that happened during the study?						
Treatment	25.0	17.5	6.5	18.0	6.0	χ^2 (1) = 0.105
Control	23.0	17.5	6.5	17.0	7.0	p = 0.745
						n = 46
Did this experience affect your perception of daily encounters in regards to energy conservation?						
Treatment	25.0	12.5	11.5	13.0	11.0	χ^2 (1) = 0.083
Control	23.0	12.5	11.5	12.0	12.0	p = 0.773
						n = 46
Did this experience affect your behavioral decision-making in regards to energy conservation?						
Treatment	25.0	12.0	12.0	13.0	11.0	χ^2 (1) = 0.333
Control	23.0	12.0	12.0	11.0	13.0	p = 0.564
						n = 46

Did this experience affect your actual behaviors in regards to energy conservation?						
Treatment	25.0	9.0	15.0	11.0	13.0	χ^2 (1) = 1.422
Control	23.0	9.0	15.0	7.0	17.0	p = 0.233
						n = 46

*p < 0.05, **p < 0.01, ***p < 0.001

The seven-day follow-up included a unique set of questions that were related to their energy conservation behaviors after the study. No significant differences for both the treatment and control condition were observed when asked if they had thought about anything that happened during the study, if their perceptions of daily encounters in regards to energy conservation were affected, if their behavioral decision-making in regards to energy conservation was affected, or if this experience affected their actual behaviors in regards to energy conservation. Previous literature that investigated personal values linked to energy-efficient behaviors in the home revealed that people were resistant to the adoption of behaviors that would require investments that limited their capacity for daily activities, such as buying a smaller refrigerator (Mirosa et al., 2013). Therefore, these findings complement the results of the seven-day follow-up because the intervention was not strong enough to affect their personal values when faced with the inconvenience associated with energy conservation. However, it was important to note that the treatment condition received a higher affirmative raw score than the control condition, which indicated that they did partake in these behaviors more, overall.

Conclusion

This study examined the relationship between video games as a treatment option for affecting shifts in attitudes, perceptions, and behaviors pertaining to energy conservation. The video game used in this research was called "7 Days to Die," a sandbox video game with an integrated crafting system that also displays human vital statistics of players' avatars. The main task was to perform in-game gathering, processing, and consumption of resources as an abstract representation of the necessary allocation of cognitive resources required for dealing with hunger. Participants assigned to the treatment group were presented with a video tutorial in order to familiarize them on the video game task that they were assigned to complete, while the control group only viewed the tutorial. This was done in order to isolate the effects of video gameplay.

By using a pre-test, post-test, and seven-day follow-up of survey items that were referenced from existing literature, statistical analysis via chi-square, independent samples t-test, and pairwise comparisons were able to identify significant differences in attitudes, perceptions, and behaviors from self-reports. It was important to understand that the sample population consisted of university students. As such, the behavioral survey items were modified to fit within the scope of common behaviors that students would partake in, such as biking to commute. Moreover, the treatment group comprised of several graduate students along with undergraduate students, while the control group solely consisted of undergraduates. Therefore, the dormitory lifestyle commonly experienced by undergraduates did not provide detailed data on their energy usage frequently, while graduate students who lived in apartments and houses received a monthly utility bill, and could have impacted both significant and non-significant results. This was especially the case where the control condition demonstrated significant differences over time, while the treatment did not do so.

Limitations

In order to maintain academic honesty and integrity, it is imperative to mention limitations that I encountered. This study relies on a Likert scale as a measurement tool that it was subjective and open to many interpretations that could either support or refute the claims made within this research. As such, it opens many doors for criticism because it may not have enough significant impact to contribute to the existing body of literature that primarily involved identifying and addressing attitudes, perceptions, and behaviors towards environmental sustainability, specifically within the context of energy conservation.

Furthermore, it may not have been desirable enough to the public domain, and also the researchers who were and are currently invested/involved with this type of research. The novelty in this methodology could serve as a deterrent for others to pursue the research I attempted to explore, which was dependent upon the audiences' personal disposition towards mediated experiences within a virtual environment, rather than the physical environment that researchers are attempting to influence now. A real, physical experience cannot compare to a digital experience because of the differences in musculoskeletal execution for performing tasks such as gathering wood with bare hands and using bare hands to gather wood at the click of a button. Additionally, the intensity and behavioral protocol serves as a reminder that this study was limited by the physical nature in which performance was assessed.

Moreover, the small sample size was indicative of data that could easily encounter skepticism, and so the results may not have been entirely indicative of a broader distribution of attitudes, perceptions, and behaviors of energy conservation. Although the sample size was enough to satisfy the student's t-distribution bias, one cannot help but point out that the distribution in the sample population was extremely biased towards college-aged students

because that was the population sample for this study. Therefore, this was not reliable on a global-scale. Additionally, many of the studies used as the foundation for this research contained survey items that were omitted because the population was limited to students; they were deemed inapplicable or not insightful enough to be included. One notable example was omitting the survey item that probed for driving a car because there were few students who drove, or even owned a car.

Fifteen-minutes of intervention exposure presented itself as a limitation as well. This was because an effective treatment may not have been observed because of how challenging it was for participants to become accustomed to the game. They were learning as they went, despite having a tutorial walkthrough, and had encountered difficulties with navigation, the user interface, and remembering subsequent tasks. Perhaps this was a significant limiting factor and thus opens the suggestion for longer exposure time. In addition, the seven-day follow-up may not have been as compelling as thirty-day follow-up.

However, the larger issue was that this study was observing the impact of experiences with video gaming, specifically the absence of expertise. It is understandable that participants would not feel as impacted if they were not absorbed into the game. After all, immersion can only be distracted if players are uncomfortable with basic controls, are still in the process of learning, and have not yet acquired mastery. Multiple trials could also be implemented in order to increase mastery and immersion too, potentially.

Predispositions towards energy conservation were variable across individuals, meaning that different people had different baseline attitudes, perceptions, and behaviors towards energy conservation and sustainability in general. Also, there were participants who cared about video games, and those who simply did not; differences in dispositions towards both sustainability and

video gaming presented itself as an impediment to determine the true level of significance that the pre-posttests attempted to identify. Whatever the individual believed was whatever the individual believed. This methodology was not enough to satisfy the criteria for establishing a shift in attitudes, perceptions, and behaviors, but rather, it was not engaging enough to impact them. In this regard, there lies a clear difference here, which is discussed in the next section where novel technologies such as virtual reality (VR) and recent literature concerning embodiment principles will come into play.

Future Research

In this relatively small body of literature, I attempted to make the first steps towards opening the doors of introducing a novel method for addressing attitudes, perceptions, and behaviors towards energy conservation. The intervention relied upon a video game that had already been in the works and has yet to be released. In the event that new technologies are still desirable when addressing the concerns of educational experiences for energy conservation, it could be a considerably cost-effective method to introduce a partially constructed intervention in the interest of time.

However, I would recommend the use of VR in the field. The level of effectiveness that video gaming and virtual experiences can have as a tool for researchers within this field, and also those who wish to study interventions that directly influence not only perceptions and attitudes, but also behaviors. Although majority of people within a given population may be able to identify, and even empathize, with a problem that is prevalent on a global-scale, learned helplessness discourages people from not only trying to self-perpetuate behaviors that address wasted energy, but also influence others to follow along the same path. By introducing a virtual

experience, I attempted to address learned helplessness by isolating a global mindset into a localized digital space. I believe this is the first step towards empowerment and reinforcement for shifting behaviors, and this is because behaviors are what truly matter in addressing our local and global environments. Novel technology such as VR can serve as a stronger, more salient, perhaps an even more significant intervention (Ahn et al., 2016). I argue that VR is immersive enough for participants to encounter an embodiment effect, where the lines between virtual experiences and physical ones become more blurred, and thus introducing the possibility of addressing one of the limitations mentioned, specifically on the differences between a physical experience and a digital one. Prolonged exposure to interventions would be greatly beneficial for newcomers to VR technology and become accustomed to the controls for greater expertise. In addition, there is strong evidence to emphasize the importance of movement and learning (Jensen, 2005, p. 60). Exercise affects cognition because of the connectivity between the cerebellum and other cortical areas responsible for sensory modalities and motor task rehearsal. The observable outcomes of this gross-motor task sequence are demonstrated by fMRI scans that show activation in these areas during predicting, sequencing, ordering, timing, and rehearsal before a task in mind is executed. Therefore, the physical movements required for a VR experience show promise to complement predictive cognitive efforts, and could have a great impact for educational endeavors, primarily because learning and movement are not distinctly separated when processed in the mind.

Final Statement

Video games are another form of media, perhaps one of the most influential forms of entertainment due to its active inclusion of participants to allocate cognitive resources for

directing experiences. Since the brain may not differentiate mediated experiences from real ones, the opportunity to study the effect of video games within the purview of sustainability, specifically energy conservation in response to resource depletion, is now becoming more salient as more people are playing video games. As such, it is important to discern the appropriate video games that researchers can use in order to achieve their goals, so that they may curate captivating experiences that illuminate the possibilities of adopting a novel mental model for transfer into the daily lives of human beings. To provide a full breakdown of the costs associated with supporting their livelihood, human beings can be presented with information that would have otherwise been difficult to access. Most people think to purchase food from a grocery store in order to gather raw materials for processing, with tools also purchased from a vendor, and then consumed. However, the reality of this world is that these raw materials did not originate at the grocery store, and the tools used were crafted by others; not themselves. A moment of reflection is all that is necessary to re-evaluate one's holistic perspective of the world around them.

APPENDICES

Appendix A

Consent Form

I am asking you to participate in a research study. I will describe this study to you and answer any of your questions.

What we will ask you to do

I will provide a survey and then ask you to play a computer video game that requires some practice trials, a test trial, and then finally another survey.

Risks and discomforts

- Potentially disturbing in-game ambient audio (eerie sounds).

Benefit

We hope to learn more about in-game behavior and how it reflects on attitudes, feelings, and other behavioral predictions relating to energy conservation.

Compensation for participation

Participants will receive compensation via $15 gift card payment or extra credit through SONA for being in the study.

Privacy/Confidentiality/Data Security

Protecting the participant's privacy and/or confidentiality includes:

- *De-identification of data with identifiers, or keep identifying information separate from research data (e.g. signed consent forms were kept separate from the survey data and that the two will not be connected)*
- *Physical security of data/research files*
- *Only the researcher and PI will have access to identifying information*
- *Sensitive data were kept on a local hard drive of the researcher's personal computer*

We anticipate that your participation in this survey presents no greater risk than everyday use of the Internet.

Please note that email communication is neither private nor secure. Though I am taking precautions to protect your privacy, you should be aware that information sent through e-mail could be read by a third party.

Your confidentiality were kept to the degree permitted by the technology being used. We cannot guarantee against interception of data sent via the internet by third parties

Data Sharing

De-identified data from this study may be shared with the research community at large to advance science and health. We will remove or code any personal information that could identify you before files are shared with other researchers to ensure that, by current scientific standards and known methods, no one were able to identify you from the information we share. Despite these measures, we cannot guarantee anonymity of your personal data.

Taking part is voluntary

Your involvement is voluntary, but you are required to complete all research materials including answering all survey questions and following the procedures. However, you may refuse to participate before the study begins and have no effect on the compensation earned before withdrawing, or their academic standing, record, or relationship with the university or other organization or service that may be involved with the research.

If you have questions

The main researcher conducting this study is Dan Moon a graduate student at Cornell University. Please ask any questions you have now. If you have questions later, you may contact me at dm793@cornell.edu or at 424-241-7103. If you have any questions or concerns regarding your rights as a subject in this study, you may contact the Institutional Review Board (IRB) for Human Participants at 607-255-5138 or access their website at http://www.irb.cornell.edu. You may also report your concerns or complaints anonymously through Ethicspoint online at www.hotline.cornell.edu or by calling toll free at 1-866-293-3077. Ethicspoint is an independent organization that serves as a liaison between the University and the person bringing the complaint so that anonymity can be ensured.

Statement of Consent

I have read the above information and have received answers to any questions I asked. I consent to take part in the study.

Your Signature_____ Date_____

Your Name (printed)_____

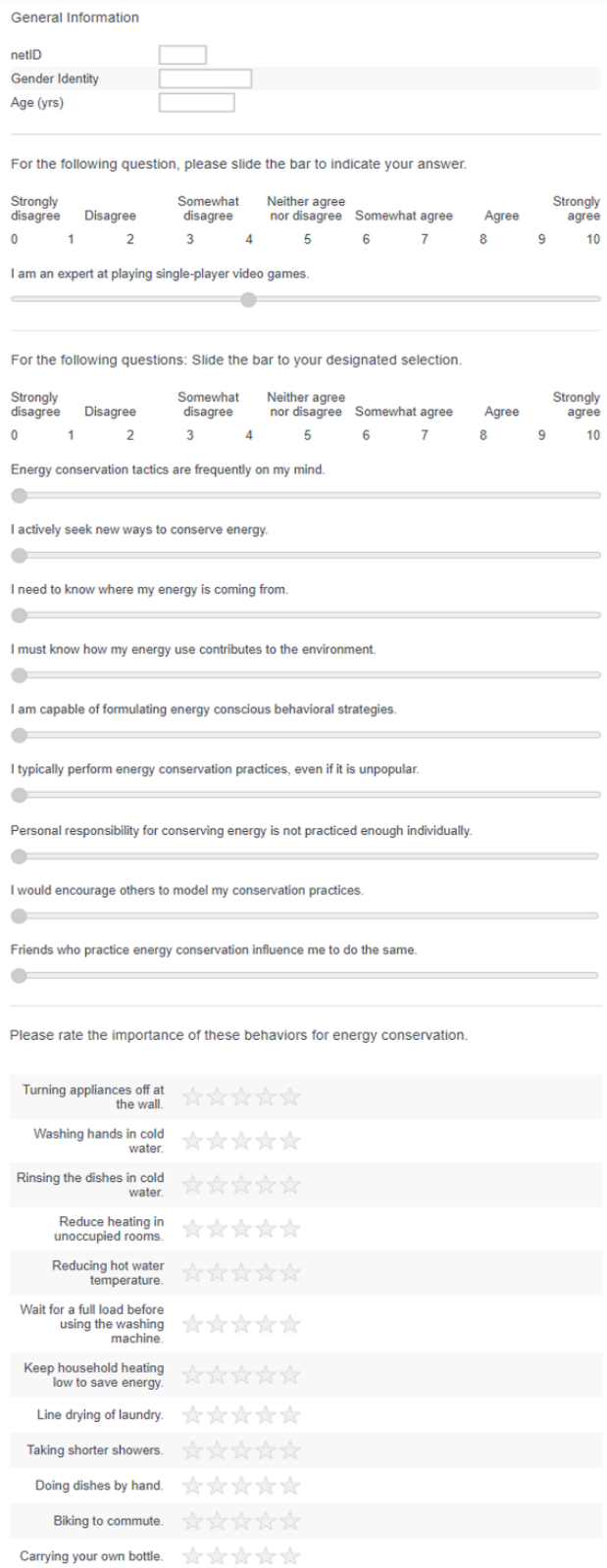
Signature of person obtaining consent_____ Date_____

Printed name of person obtaining consent_____

This consent form will be kept by the researcher for one year beyond the end of the study.

Appendix B

Pre-Test Questionnaire



General Information

netID

Gender Identity

Age (yrs)

For the following question, please slide the bar to indicate your answer.

Strongly disagree | Disagree | Somewhat disagree | Neither agree nor disagree | Somewhat agree | Agree | Strongly agree

0 1 2 3 4 5 6 7 8 9 10

I am an expert at playing single-player video games.

For the following questions: Slide the bar to your designated selection.

Strongly disagree | Disagree | Somewhat disagree | Neither agree nor disagree | Somewhat agree | Agree | Strongly agree

0 1 2 3 4 5 6 7 8 9 10

Energy conservation tactics are frequently on my mind.

I actively seek new ways to conserve energy.

I need to know where my energy is coming from.

I must know how my energy use contributes to the environment.

I am capable of formulating energy conscious behavioral strategies.

I typically perform energy conservation practices, even if it is unpopular.

Personal responsibility for conserving energy is not practiced enough individually.

I would encourage others to model my conservation practices.

Friends who practice energy conservation influence me to do the same.

Please rate the importance of these behaviors for energy conservation.

Turning appliances off at the wall.

Washing hands in cold water.

Rinsing the dishes in cold water.

Reduce heating in unoccupied rooms.

Reducing hot water temperature.

Wait for a full load before using the washing machine.

Keep household heating low to save energy.

Line drying of laundry.

Taking shorter showers.

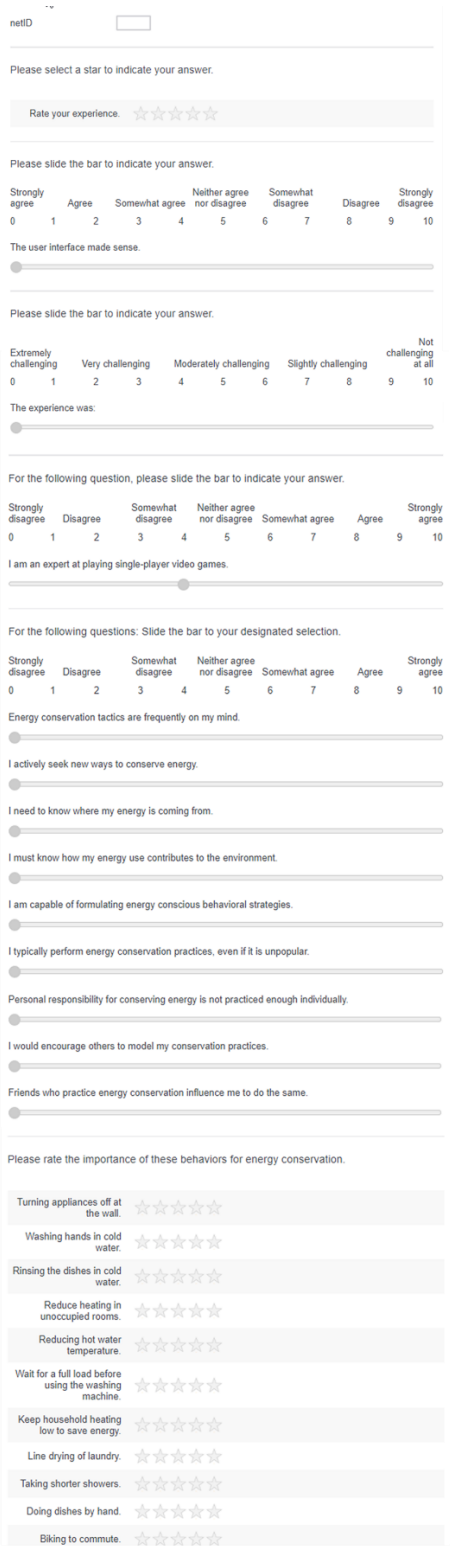
Doing dishes by hand.

Biking to commute.

Carrying your own bottle.

Appendix C

Post-Test Questionnaire



netID

Please select a star to indicate your answer.

Rate your experience.

Please slide the bar to indicate your answer.

Strongly agree | Agree | Somewhat agree | Neither agree nor disagree | Somewhat disagree | Disagree | Strongly disagree

0 1 2 3 4 5 6 7 8 9 10

The user interface made sense.

Please slide the bar to indicate your answer.

Extremely challenging | Very challenging | Moderately challenging | Slightly challenging | Not challenging at all

0 1 2 3 4 5 6 7 8 9 10

The experience was:

For the following question, please slide the bar to indicate your answer.

Strongly disagree | Disagree | Somewhat disagree | Neither agree nor disagree | Somewhat agree | Agree | Strongly agree

0 1 2 3 4 5 6 7 8 9 10

I am an expert at playing single-player video games.

For the following questions: Slide the bar to your designated selection.

Strongly disagree | Disagree | Somewhat disagree | Neither agree nor disagree | Somewhat agree | Agree | Strongly agree

0 1 2 3 4 5 6 7 8 9 10

Energy conservation tactics are frequently on my mind.

I actively seek new ways to conserve energy.

I need to know where my energy is coming from.

I must know how my energy use contributes to the environment.

I am capable of formulating energy conscious behavioral strategies.

I typically perform energy conservation practices, even if it is unpopular.

Personal responsibility for conserving energy is not practiced enough individually.

I would encourage others to model my conservation practices.

Friends who practice energy conservation influence me to do the same.

Please rate the importance of these behaviors for energy conservation.

Turning appliances off at the wall.

Washing hands in cold water.

Rinsing the dishes in cold water.

Reduce heating in unoccupied rooms.

Reducing hot water temperature.

Wait for a full load before using the washing machine.

Keep household heating low to save energy.

Line drying of laundry.

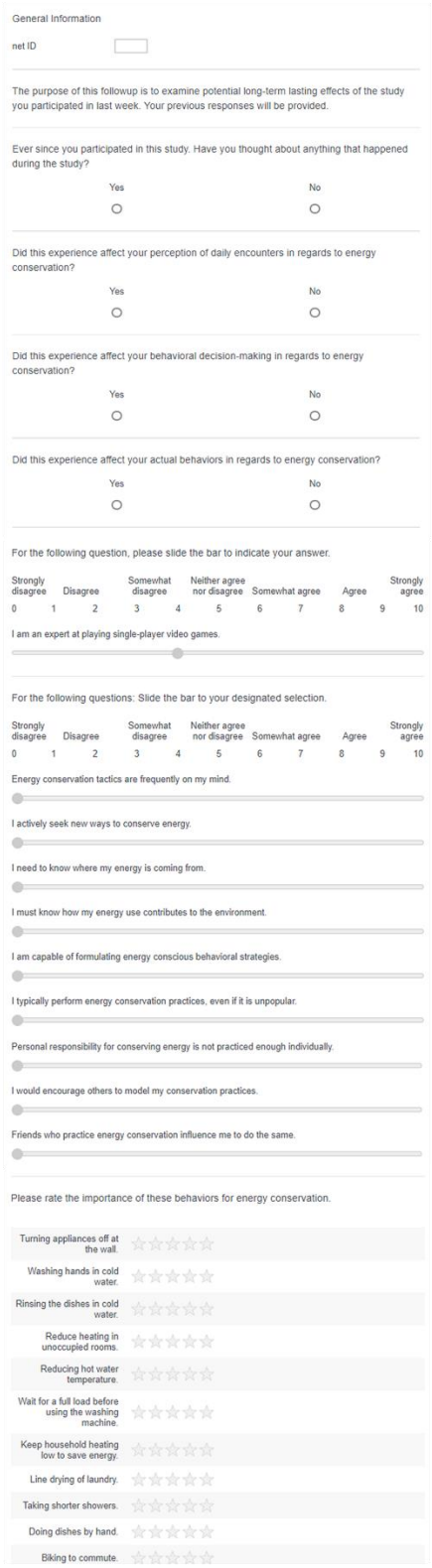
Taking shorter showers.

Doing dishes by hand.

Biking to commute.

Appendix D

7-Day follow-up Questionnaire



General Information

net ID

The purpose of this followup is to examine potential long-term lasting effects of the study you participated in last week. Your previous responses will be provided.

Ever since you participated in this study. Have you thought about anything that happened during the study?

Yes ○ No ○

Did this experience affect your perception of daily encounters in regards to energy conservation?

Yes ○ No ○

Did this experience affect your behavioral decision-making in regards to energy conservation?

Yes ○ No ○

Did this experience affect your actual behaviors in regards to energy conservation?

Yes ○ No ○

For the following question, please slide the bar to indicate your answer.

Strongly disagree 0 | Disagree 1 | 2 | Somewhat disagree 3 | 4 | Neither agree nor disagree 5 | 6 | Somewhat agree 7 | Agree 8 | 9 | Strongly agree 10

I am an expert at playing single-player video games.

For the following questions: Slide the bar to your designated selection.

Strongly disagree 0 | Disagree 1 | 2 | Somewhat disagree 3 | 4 | Neither agree nor disagree 5 | 6 | Somewhat agree 7 | Agree 8 | 9 | Strongly agree 10

Energy conservation tactics are frequently on my mind.

I actively seek new ways to conserve energy.

I need to know where my energy is coming from.

I must know how my energy use contributes to the environment.

I am capable of formulating energy conscious behavioral strategies.

I typically perform energy conservation practices, even if it is unpopular.

Personal responsibility for conserving energy is not practiced enough individually.

I would encourage others to model my conservation practices.

Friends who practice energy conservation influence me to do the same.

Please rate the importance of these behaviors for energy conservation.

Turning appliances off at the wall.	☆☆☆☆☆
Washing hands in cold water.	☆☆☆☆☆
Rinsing the dishes in cold water.	☆☆☆☆☆
Reduce heating in unoccupied rooms.	☆☆☆☆☆
Reducing hot water temperature.	☆☆☆☆☆
Wait for a full load before using the washing machine.	☆☆☆☆☆
Keep household heating low to save energy.	☆☆☆☆☆
Line drying of laundry.	☆☆☆☆☆
Taking shorter showers.	☆☆☆☆☆
Doing dishes by hand.	☆☆☆☆☆
Biking to commute.	☆☆☆☆☆

Appendix E

Table E1

Results of a pairwise comparison between Time 1 (Pre-test), Time 2 (Post-test), and Time 3 (7-Day follow-up) from the treatment group. First twelve values are based on a 10-point Likert scale. The subsequent values are based on a 5-star rating.

Questions	(I) Mean	(J) Mean	Mean Difference (I-J)	Std. Error	df	Sig.[a]	95% Confidence Interval for Difference[a]	
							Lower Bound	Upper Bound
Energy conservation tactics are frequently on my mind.	Pretest (5.43)	Posttest (6.55)	-1.12	0.575	72	0.166	-2.529	0.289
		7-day (6.330)	-0.88	0.575	72	0.39	-2.289	0.529
	Posttest (6.55)	Pretest (5.43)	1.12	0.575	72	0.166	-0.289	2.529
		7-day (6.330)	0.24	0.575	72	1	-1.169	1.649
	7-day (6.330)	Pretest (5.43)	0.88	0.575	72	0.39	-0.529	2.289
		Posttest (6.55)	-0.24	0.575	72	1	-1.649	1.169
I actively seek new ways to conserve energy.	Pretest (5.485)	Posttest (6.245)	-0.76	0.602	72	0.633	-2.236	0.716
		7-day (5.845)	-0.36	0.602	72	1	-1.836	1.116
	Posttest (6.245)	Pretest (5.485)	0.76	0.602	72	0.633	-0.716	2.236
		7-day (5.845)	0.4	0.602	72	1	-1.076	1.876
	7-day (5.845)	Pretest (5.485)	0.36	0.602	72	1	-1.116	1.836
		Posttest (6.245)	-0.4	0.602	72	1	-1.876	1.076
I need to know where my energy is coming from.	Pretest (4.463)	Posttest (6.103)	-1.640*	0.654	72	0.043	-3.244	-0.036
		7-day (4.695)	-0.24	0.654	72	1	-1.844	1.364
	Posttest (6.103)	Pretest (4.463)	1.640*	0.654	72	0.043	0.036	3.244
		7-day (4.695)	1.4	0.654	72	0.107	-0.204	3.004
	7-day (4.695)	Pretest (4.463)	0.24	0.654	72	1	-1.364	1.844
		Posttest (6.103)	-1.4	0.654	72	0.107	-3.004	0.204
I must know how my energy use contributes to the environment.	Pretest (5.426)	Posttest (5.426)	7.22E-16	0.644	72	1	-1.579	1.579
		7-day (5.176)	0.24	0.644	72	1	-1.339	1.819
	Posttest (5.426)	Pretest (5.426)	-7.22E-16	0.644	72	1	-1.579	1.579
		7-day (5.176)	0.24	0.644	72	1	-1.339	1.819

	7-day (5.176)	Pretest (5.426)	-0.24	0.644	72	1	-1.819	1.339
		Posttest (5.426)	-0.24	0.644	72	1	-1.819	1.339
I am capable of formulating energy conscious behavioral strategies.	Pretest (6.010)	Posttest (6.530)	-0.52	0.54	72	1	-1.843	0.803
		7-day (6.924)	-0.92	0.54	72	0.278	-2.243	0.403
	Posttest (6.530)	Pretest (6.010)	0.52	0.54	72	1	-0.803	1.843
		7-day (6.924)	-0.4	0.54	72	1	-1.723	0.923
	7-day (6.924)	Pretest (6.010)	0.92	0.54	72	0.278	-0.403	2.243
		Posttest (6.530)	0.4	0.54	72	1	-0.923	1.723
I typically perform energy conservation practices, even if it is unpopular.	Pretest (4.619)	Posttest (6.579)	-1.960**	0.641	72	0.009	-3.531	-0.389
		7-day (5.680)	-1.04	0.641	72	0.327	-2.611	0.531
	Posttest (6.579)	Pretest (4.619)	1.960**	0.641	72	0.009	0.389	3.531
		7-day (5.680)	0.92	0.641	72	0.467	-0.651	2.491
	7-day (5.680)	Pretest (4.619)	1.04	0.641	72	0.327	-0.531	2.611
		Posttest (6.579)	-0.92	0.641	72	0.467	-2.491	0.651
Awareness for energy conservation is not effective enough as behavioral action.	Pretest (6.855)	Posttest (6.135)	0.72	0.696	72	0.913	-0.986	2.426
		7-day (6.657)	0.2	0.696	72	1	-1.506	1.906
	Posttest (6.135)	Pretest (6.855)	-0.72	0.696	72	0.913	-2.426	0.986
		7-day (6.657)	-0.52	0.696	72	1	-2.226	1.186
	7-day (6.657)	Pretest (6.855)	-0.2	0.696	72	1	-1.906	1.506
		Posttest (6.135)	0.52	0.696	72	1	-1.186	2.226
Watching educational videos on energy conservation are tiring.	Pretest (5.235)	Posttest (5.835)	-0.6	0.7	72	1	-2.315	1.115
		7-day (4.827)	0.32	0.7	72	1	-1.395	2.035
	Posttest (5.835)	Pretest (5.235)	0.6	0.7	72	1	-1.115	2.315
		7-day (4.827)	0.92	0.7	72	0.578	-0.795	2.635
	7-day (4.827)	Pretest (5.235)	-0.32	0.7	72	1	-2.035	1.395
		Posttest (5.835)	-0.92	0.7	72	0.578	-2.635	0.795
Personal responsibility for conserving energy is not practiced	Pretest (7.229)	Posttest (6.549)	0.68	0.536	72	0.627	-0.634	1.994
		7-day (7.197)	-0.04	0.536	72	1	-1.354	1.274
	Posttest (6.549)	Pretest (7.229)	-0.68	0.536	72	0.627	-1.994	0.634

enough individually.		7-day (7.197)	-0.72	0.536	72	0.551	-2.034	0.594
	7-day (7.197)	Pretest (7.229)	0.04	0.536	72	1	-1.274	1.354
		Posttest (6.549)	0.72	0.536	72	0.551	-0.594	2.034
I would encourage others to model my conservation practices.	Pretest (4.067)	Posttest (7.827)	-3.760***	0.611	72	.000	-5.257	-2.263
		7-day (5.219)	-1.2	0.611	72	0.16	-2.697	0.297
	Posttest (7.827)	Pretest (4.067)	3.760***	0.611	72	.000	2.263	5.257
		7-day (5.219)	2.560***	0.611	72	.000	1.063	4.057
	7-day (5.219)	Pretest (4.067)	1.2	0.611	72	0.16	-0.297	2.697
		Posttest (7.827)	-2.560*	0.611	72	.000	-4.057	-1.063
Friends who practice energy conservation influence me to do the same.	Pretest (4.067)	Posttest (7.827)	-0.48	0.668	72	1	-2.116	1.156
		7-day (5.219)	-0.24	0.668	72	1	-1.876	1.396
	Posttest (7.827)	Pretest (4.067)	0.48	0.668	72	1	-1.156	2.116
		7-day (5.219)	0.24	0.668	72	1	-1.396	1.876
	7-day (5.219)	Pretest (4.067)	0.24	0.668	72	1	-1.396	1.876
		Posttest (7.827)	-0.24	0.668	72	1	-1.876	1.396
My main reason for conserving energy is to save money.	Pretest (6.190)	Posttest (6.670)	-1.840**	0.588	72	0.008	-3.282	-0.398
		7-day (6.364)	-0.6	0.588	72	0.933	-2.042	0.842
	Posttest (6.670)	Pretest (6.190)	1.840**	0.588	72	0.008	0.398	3.282
		7-day (6.364)	1.24	0.588	72	0.115	-0.202	2.682
	7-day (6.364)	Pretest (6.190)	0.6	0.588	72	0.933	-0.842	2.042
		Posttest (6.670)	-1.24	0.588	72	0.115	-2.682	0.202
Turning appliances off at the wall.	Pretest (3.598)	Posttest (3.998)	-0.4	0.308	72	0.596	-1.156	0.356
		7-day (4.228)	-0.62	0.308	72	0.144	-1.376	0.136
	Posttest (3.998)	Pretest (3.598)	0.4	0.308	72	0.596	-0.356	1.156
		7-day (4.228)	-0.22	0.308	72	1	-0.976	0.536
	7-day (4.228)	Pretest (3.598)	0.62	0.308	72	0.144	-0.136	1.376
		Posttest (3.998)	0.22	0.308	72	1	-0.536	0.976
Washing hands in cold water.	Pretest (2.760)	Posttest (2.820)	-0.06	0.292	72	1	-0.776	0.656
		7-day (3.176)	-0.4	0.292	72	0.526	-1.116	0.316

	Posttest (2.820)	Pretest (2.760)	0.06	0.292	72	1	-0.656	0.776
		7-day (3.176)	-0.34	0.292	72	0.745	-1.056	0.376
	7-day (3.176)	Pretest (2.760)	0.4	0.292	72	0.526	-0.316	1.116
		Posttest (2.820)	0.34	0.292	72	0.745	-0.376	1.056
Rinsing the dishes in cold water.	Pretest (2.958)	Posttest (3.018)	-0.06	0.297	72	1	-0.788	0.668
		7-day (3.168)	-0.2	0.297	72	1	-0.928	0.528
	Posttest (3.018)	Pretest (2.958)	0.06	0.297	72	1	-0.668	0.788
		7-day (3.168)	-0.14	0.297	72	1	-0.868	0.588
	7-day (3.168)	Pretest (2.958)	0.2	0.297	72	1	-0.528	0.928
		Posttest (3.018)	0.14	0.297	72	1	-0.588	0.868
Reduce heating in unoccupied rooms.	Pretest (4.449)	Posttest (4.469)	-0.02	0.188	72	1	-0.481	0.441
		7-day (4.441)	5.00E-15	0.188	72	1	-0.461	0.461
	Posttest (4.469)	Pretest (4.449)	0.02	0.188	72	1	-0.441	0.481
		7-day (4.441)	0.02	0.188	72	1	-0.441	0.481
	7-day (4.441)	Pretest (4.449)	-5.00E-15	0.188	72	1	-0.461	0.461
		Posttest (4.469)	-0.02	0.188	72	1	-0.481	0.441
Reducing hot water temperature.	Pretest (3.152)	Posttest (3.612)	-0.46	0.271	72	0.283	-1.125	0.205
		7-day (3.598)	-0.46	0.271	72	0.283	-1.125	0.205
	Posttest (3.612)	Pretest (3.152)	0.46	0.271	72	0.283	-0.205	1.125
		7-day (3.598)	-7.53E-15	0.271	72	1	-0.665	0.665
	7-day (3.598)	Pretest (3.152)	0.46	0.271	72	0.283	-0.205	1.125
		Posttest (3.612)	7.53E-15	0.271	72	1	-0.665	0.665
Wait for a full load before using the washing machine.	Pretest (4.271)	Posttest (4.431)	-0.16	0.206	72	1	-0.665	0.345
		7-day (4.484)	-0.22	0.206	72	0.866	-0.725	0.285
	Posttest (4.431)	Pretest (4.271)	0.16	0.206	72	1	-0.345	0.665
		7-day (4.484)	-0.06	0.206	72	1	-0.565	0.445
	7-day (4.484)	Pretest (4.271)	0.22	0.206	72	0.866	-0.285	0.725
		Posttest (4.431)	0.06	0.206	72	1	-0.445	0.565
	Pretest (3.956)	Posttest (3.956)	-1.50E-15	0.326	72	1	-0.799	0.799

		7-day (3.796)	0.08	0.326	72	1	-0.719	0.879
	Posttest (3.956)	Pretest (3.956)	1.50E-15	0.326	72	1	-0.799	0.799
Taking shorter showers.		7-day (3.796)	0.08	0.326	72	1	-0.719	0.879
	7-day (3.796)	Pretest (3.956)	-0.08	0.326	72	1	-0.879	0.719
		Posttest (3.956)	-0.08	0.326	72	1	-0.879	0.719
Doing dishes by hand.	Pretest (3.972)	Posttest (3.952)	0.02	0.31	72	1	-0.74	0.78
		7-day (3.761)	0.18	0.31	72	1	-0.58	0.94
	Posttest (3.952)	Pretest (3.972)	-0.02	0.31	72	1	-0.78	0.74
		7-day (3.761)	0.16	0.31	72	1	-0.6	0.92
	7-day (3.761)	Pretest (3.972)	-0.18	0.31	72	1	-0.94	0.58
		Posttest (3.952)	-0.16	0.31	72	1	-0.92	0.6
Biking to commute.	Pretest (3.191)	Posttest (3.151)	0.04	0.325	72	1	-0.756	0.836
		7-day (3.277)	-0.56	0.325	72	0.267	-1.356	0.236
	Posttest (3.151)	Pretest (3.191)	-0.04	0.325	72	1	-0.836	0.756
		7-day (3.277)	-0.6	0.325	72	0.206	-1.396	0.196
	7-day (3.277)	Pretest (3.191)	0.56	0.325	72	0.267	-0.236	1.356
		Posttest (3.151)	0.6	0.325	72	0.206	-0.196	1.396

*p < 0.05, **p < 0.01, ***p < 0.001

a. Adjustment for multiple comparisons: Bonferroni ($\frac{\alpha}{3}$ = 0.0167). Values of 1 are truncated.

Table E2

Results of a pairwise comparison between Time 1 (Pre-test), Time 2 (Post-test), and Time 3 (7-Day follow-up) from the control group. First twelve values are based on a 10-point Likert scale. The subsequent values are based on a 5-star rating.

Questions	(I) Mean	(J) Mean	Mean Difference (I-J)	Std. Error	df	Sig.[a]	95% Confidence Interval for Difference[a]	
							Lower Bound	Upper Bound
Energy conservation tactics are frequently on my mind.	Pretest (4.739)	Posttest (6.245)	-1.609	0.689	66	0.068	-3.302	0.085
		7-day (5.654)	-1.348	0.689	66	0.164	-3.041	0.346
	Posttest (6.245)	Pretest (4.739)	1.609	0.689	66	0.068	-0.085	3.302
		7-day (5.654)	0.261	0.689	66	1	-1.433	1.955
	7-day (5.654)	Pretest (4.739)	1.348	0.689	66	0.164	-0.346	3.041
		Posttest (6.245)	-0.261	0.689	66	1	-1.955	1.433
I actively seek new ways to conserve energy.	Pretest (4.390)	Posttest (6.098)	-1.783*	0.624	66	0.017	-3.315	-0.251
		7-day (5.462)	-1.348	0.624	66	0.103	-2.88	0.184
	Posttest (6.098)	Pretest (4.390)	1.783*	0.624	66	0.017	0.251	3.315
		7-day (5.462)	0.435	0.624	66	1	-1.097	1.967
	7-day (5.462)	Pretest (4.390)	1.348	0.624	66	0.103	-0.184	2.88
		Posttest (6.098)	-0.435	0.624	66	1	-1.967	1.097
I need to know where my energy is coming from.	Pretest (4.563)	Posttest (5.760)	-1.174	0.6	66	0.164	-2.648	0.3
		7-day (5.231)	-0.87	0.6	66	0.456	-2.343	0.604
	Posttest (5.760)	Pretest (4.563)	1.174	0.6	66	0.164	-0.3	2.648
		7-day (5.231)	0.304	0.6	66	1	-1.169	1.778
	7-day (5.231)	Pretest (4.563)	0.87	0.6	66	0.456	-0.604	2.343
		Posttest (5.760)	-0.304	0.6	66	1	-1.778	1.169
I must know how my energy use contributes to the environment.	Pretest (4.372)	Posttest (5.656)	-1.087	0.537	66	0.141	-2.407	0.233
		7-day (5.346)	-1.087	0.537	66	0.141	-2.407	0.233
	Posttest (5.656)	Pretest (4.372)	1.087	0.537	66	0.141	-0.233	2.407
		7-day (5.346)	1.39E-15	0.537	66	1	-1.32	1.32
	7-day (5.346)	Pretest (4.372)	1.087	0.537	66	0.141	-0.233	2.407
		Posttest (5.656)	-1.39E-15	0.537	66	1	-1.32	1.32

I am capable of formulating energy conscious behavioral strategies.	Pretest (5.229)	Posttest (6.195)	-0.913	0.629	66	0.454	-2.458	0.632
		7-day (7.115)	-1.870*	0.629	66	0.012	-3.414	-0.325
	Posttest (6.195)	Pretest (5.229)	0.913	0.629	66	0.454	-0.632	2.458
		7-day (7.115)	-0.957	0.629	66	0.399	-2.501	0.588
	7-day (7.115)	Pretest (5.229)	1.870*	0.629	66	0.012	0.325	3.414
		Posttest (6.195)	0.957	0.629	66	0.399	-0.588	2.501
I typically perform energy conservation practices, even if it is unpopular.	Pretest (4.619)	Posttest (5.818)	-1.043	0.607	66	0.271	-2.534	0.447
		7-day (5.385)	-0.913	0.607	66	0.412	-2.404	0.578
	Posttest (5.818)	Pretest (4.619)	1.043	0.607	66	0.271	-0.447	2.534
		7-day (5.385)	0.13	0.607	66	1	-1.36	1.621
	7-day (5.385)	Pretest (4.619)	0.913	0.607	66	0.412	-0.578	2.404
		Posttest (5.818)	-0.13	0.607	66	1	-1.621	1.36
Awareness for energy conservation is not effective enough as behavioral action.	Pretest (5.855)	Posttest (6.355)	-0.522	0.703	66	1	-2.25	1.206
		7-day (7.077)	-1.087	0.703	66	0.381	-2.815	0.641
	Posttest (6.355)	Pretest (5.855)	0.522	0.703	66	1	-1.206	2.25
		7-day (7.077)	-0.565	0.703	66	1	-2.293	1.163
	7-day (7.077)	Pretest (5.855)	1.087	0.703	66	0.381	-0.641	2.815
		Posttest (6.355)	0.565	0.703	66	1	-1.163	2.293
Watching educational videos on energy conservation are tiring.	Pretest (5.208)	Posttest (5.485)	-0.217	0.723	66	1	-1.993	1.558
		7-day (4.885)	0.174	0.723	66	1	-1.602	1.949
	Posttest (5.485)	Pretest (5.208)	0.217	0.723	66	1	-1.558	1.993
		7-day (4.885)	0.391	0.723	66	1	-1.384	2.167
	7-day (4.885)	Pretest (5.208)	-0.174	0.723	66	1	-1.949	1.602
		Posttest (5.485)	-0.391	0.723	66	1	-2.167	1.384
Personal responsibility for conserving energy is not practiced enough individually.	Pretest (6.861)	Posttest (6.748)	0.217	0.555	66	1	-1.146	1.581
		7-day (8.000)	-1	0.555	66	0.229	-2.364	0.364
	Posttest (6.748)	Pretest (6.861)	-0.217	0.555	66	1	-1.581	1.146
		7-day (8.000)	-1.217	0.555	66	0.096	-2.581	0.146
	7-day (8.000)	Pretest (6.861)	1	0.555	66	0.229	-0.364	2.364

		Posttest (6.748)	1.217	0.555	66	0.096	-0.146	2.581
I would encourage others to model my conservation practices.	Pretest (4.700)	Posttest (6.958)	-2.043**	0.641	66	0.007	-3.618	-0.469
		7-day (5.308)	-0.739	0.641	66	0.759	-2.314	0.835
	Posttest (6.958)	Pretest (4.700)	2.043**	0.641	66	0.007	0.469	3.618
		7-day (5.308)	1.304	0.641	66	0.138	-0.27	2.879
	7-day (5.308)	Pretest (4.700)	0.739	0.641	66	0.759	-0.835	2.314
	Pretest (4.700)	Posttest (6.958)	-1.304	0.641	66	0.138	-2.879	0.27
Friends who practice energy conservation influence me to do the same.	Pretest (4.700)	Posttest (6.958)	-0.739	0.545	66	0.54	-2.079	0.601
		7-day (5.308)	-0.565	0.545	66	0.911	-1.905	0.774
	Posttest (6.958)	Pretest (4.700)	0.739	0.545	66	0.54	-0.601	2.079
		7-day (5.308)	0.174	0.545	66	1	-1.166	1.514
	7-day (5.308)	Pretest (4.700)	0.565	0.545	66	0.911	-0.774	1.905
		Posttest (6.958)	-0.174	0.545	66	1	-1.514	1.166
My main reason for conserving energy is to save money.	Pretest (6.114)	Posttest (6.843)	-0.435	0.714	66	1	-2.188	1.319
		7-day (6.577)	-0.87	0.714	66	0.683	-2.623	0.884
	Posttest (6.843)	Pretest (6.114)	0.435	0.714	66	1	-1.319	2.188
		7-day (6.577)	-0.435	0.714	66	1	-2.188	1.319
	7-day (6.577)	Pretest (6.114)	0.87	0.714	66	0.683	-0.884	2.623
		Posttest (6.843)	0.435	0.714	66	1	-1.319	2.188
Turning appliances off at the wall.	Pretest (3.915)	Posttest (4.108)	-0.217	0.287	66	1	-0.921	0.487
		7-day (4.231)	-0.413	0.287	66	0.463	-1.117	0.291
	Posttest (4.108)	Pretest (3.915)	0.217	0.287	66	1	-0.487	0.921
		7-day (4.231)	-0.196	0.287	66	1	-0.9	0.508
	7-day (4.231)	Pretest (3.915)	0.413	0.287	66	0.463	-0.291	1.117
		Posttest (4.108)	0.196	0.287	66	1	-0.508	0.9
Washing hands in cold water.	Pretest (2.979)	Posttest (3.130)	-0.217	0.383	66	1	-1.158	0.723
		7-day (3.308)	-0.522	0.383	66	0.533	-1.463	0.419
	Posttest (3.130)	Pretest (2.979)	0.217	0.383	66	1	-0.723	1.158
		7-day (3.308)	-0.304	0.383	66	1	-1.245	0.636

	7-day (3.308)	Pretest (2.979)	0.522	0.383	66	0.533	-0.419	1.463
		Posttest (3.130)	0.304	0.383	66	1	-0.636	1.245
Rinsing the dishes in cold water.	Pretest (2.745)	Posttest (3.043)	-0.37	0.366	66	0.948	-1.268	0.529
		7-day (3.346)	-0.696	0.366	66	0.184	-1.594	0.203
	Posttest (3.043)	Pretest (2.745)	0.37	0.366	66	0.948	-0.529	1.268
		7-day (3.346)	-0.326	0.366	66	1	-1.224	0.572
	7-day (3.346)	Pretest (2.745)	0.696	0.366	66	0.184	-0.203	1.594
		Posttest (3.043)	0.326	0.366	66	1	-0.572	1.224
Reduce heating in unoccupied rooms.	Pretest (4.209)	Posttest (4.536)	-0.348	0.282	66	0.664	-1.04	0.344
		7-day (4.250)	-0.065	0.282	66	1	-0.757	0.627
	Posttest (4.536)	Pretest (4.209)	0.348	0.282	66	0.664	-0.344	1.04
		7-day (4.250)	0.283	0.282	66	0.959	-0.41	0.975
	7-day (4.250)	Pretest (4.209)	0.065	0.282	66	1	-0.627	0.757
		Posttest (4.536)	-0.283	0.282	66	0.959	-0.975	0.41
Reducing hot water temperature.	Pretest (2.973)	Posttest (3.451)	-0.543	0.353	66	0.385	-1.411	0.324
		7-day (3.577)	-0.717	0.353	66	0.139	-1.585	0.15
	Posttest (3.451)	Pretest (2.973)	0.543	0.353	66	0.385	-0.324	1.411
		7-day (3.577)	-0.174	0.353	66	1	-1.041	0.693
	7-day (3.577)	Pretest (2.973)	0.717	0.353	66	0.139	-0.15	1.585
		Posttest (3.451)	0.174	0.353	66	1	-0.693	1.041
Wait for a full load before using the washing machine.	Pretest (4.278)	Posttest (4.430)	-0.174	0.252	66	1	-0.792	0.444
		7-day (4.462)	-0.283	0.252	66	0.796	-0.901	0.335
	Posttest (4.430)	Pretest (4.278)	0.174	0.252	66	1	-0.444	0.792
		7-day (4.462)	-0.109	0.252	66	1	-0.727	0.509
	7-day (4.462)	Pretest (4.278)	0.283	0.252	66	0.796	-0.335	0.901
		Posttest (4.430)	0.109	0.252	66	1	-0.509	0.727
Taking shorter showers.	Pretest (3.392)	Posttest (3.639)	-0.304	0.344	66	1	-1.149	0.54
		7-day (3.720)	-0.696	0.344	66	0.141	-1.54	0.149
	Posttest (3.639)	Pretest (3.392)	0.304	0.344	66	1	-0.54	1.149

		7-day (3.720)	-0.391	0.344	66	0.777	-1.236	0.453
	7-day (3.720)	Pretest (3.392)	0.696	0.344	66	0.141	-0.149	1.54
		Posttest (3.639)	0.391	0.344	66	0.777	-0.453	1.236
Doing dishes by hand.	Pretest (3.867)	Posttest (4.066)	-0.261	0.337	66	1	-1.088	0.567
		7-day (4.000)	0.152	0.337	66	1	-0.675	0.98
	Posttest (4.066)	Pretest (3.867)	0.261	0.337	66	1	-0.567	1.088
		7-day (4.000)	0.413	0.337	66	0.674	-0.414	1.241
	7-day (4.000)	Pretest (3.867)	-0.152	0.337	66	1	-0.98	0.675
		Posttest (4.066)	-0.413	0.337	66	0.674	-1.241	0.414
Biking to commute.	Pretest (3.166)	Posttest (3.440)	-0.348	0.349	66	0.969	-1.206	0.51
		7-day (3.788)	-.957*	0.349	66	0.024	-1.815	-0.098
	Posttest (3.440)	Pretest (3.166)	0.348	0.349	66	0.969	-0.51	1.206
		7-day (3.788)	-0.609	0.349	66	0.258	-1.467	0.25
	7-day (3.788)	Pretest (3.166)	.957*	0.349	66	0.024	0.098	1.815
		Posttest (3.440)	0.609	0.349	66	0.258	-0.25	1.467

*p < 0.05, **p < 0.01, ***p < 0.001

a. Adjustment for multiple comparisons: Bonferroni ($\frac{\alpha}{3}$ = 0.0167). Values of 1 are truncated.

Table E3

Independent samples t-test of condition and survey items from the pre-test and post-test

	Condition			
	Treatment	Control	*t*	*df*
I am an expert at playing single-player video games.	2.5 (2.265)	4.0 (3.217)	*-1.868	46
Rate your experience.	4.46 (0.721)	4.13 (0.85)	1.465	46
The user interface made sense.	2.54 (2.519)	3.08 (3.078)	-0.667	46
The experience was challenging	6.71 (2.156)	7.88 (2.071)	-1.912	46

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

The degrees of freedom were modified to match the sample population size of the treatment group with the control group.

Table E4

Comparison of condition and survey items from the 7-day follow-up

Questions	Overall sample	Yes (expected)	No (expected)	Yes (count)	No (count)	Chi square tests of independence
Ever since you participated in this study. Have you thought about anything that happened during the study?						
Treatment	25.0	17.5	6.5	18.0	6.0	χ^2 (1) = 0.105
Control	23.0	17.5	6.5	17.0	7.0	p = 0.745
						n = 46
Did this experience affect your perception of daily encounters in regards to energy conservation?						
Treatment	25.0	12.5	11.5	13.0	11.0	χ^2 (1) = 0.083
Control	23.0	12.5	11.5	12.0	12.0	p = 0.773
						n = 46
Did this experience affect your behavioral decision-making in regards to energy conservation?						
Treatment	25.0	12.0	12.0	13.0	11.0	χ^2 (1) = 0.333
Control	23.0	12.0	12.0	11.0	13.0	p = 0.564
						n = 46
Did this experience affect your actual behaviors in regards to energy conservation?						
Treatment	25.0	9.0	15.0	11.0	13.0	χ^2 (1) = 1.422
Control	23.0	9.0	15.0	7.0	17.0	p = 0.233
						n = 46

*p < 0.05, **p < 0.01, ***p < 0.001

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