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Teenagers as Energy Conservation Stewards: The Dial Down Challenge

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This report was prepared by Magali Delmas (Principal Investigator), Paloma Giottonini who also coordinated the project, and Gladys Teng who conducted the data analysis.

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ABSTRACT

We conducted an experiment to explore how teenagers can become energy conservation stewards at home. In this experiment, called the Dial Down Challenge, we equipped adolescents with knowledge about electricity and water conservation behavior during a six-week online program with guided activities to be completed at home. We tested whether teenagers could transfer this knowledge to other members of their household and induce attitudinal and behavioral change. We found that knowledge, awareness, and motivation for saving energy increased among both teenagers and their parents. We also found that participants' perceptions of their agency increased across teenagers and parents. In terms of intergenerational exchange, we found that parents increased their reliance on the information provided by their children but reduced their perception of their children's agency in changing energy conservation practices at home. In other words, participants realized that energy conservation was more challenging than anticipated. Overall, the results from this small experiment demonstrate the potential of a program like the Dial Down Challenge for increasing energy conservation awareness and knowledge within the household. However, we also find that this type of experiment requires active social interactions and is difficult to implement during a pandemic when these interactions are limited.

Keywords: energy conservation, intergenerational learning

1. EXECUTIVE SUMMARY

Background

Climate change and its effects on people, ecosystems, and society are widely considered one of the most pressing issues of our time (United Nations, n.d.). As the metaphorical clock ticks down to what many scientists have described as "the point of no return," (Latif, 2009; Van Zalinge et al., 2017); much emphasis is placed on the youth of today, and future generations, who will be forced to adapt their behaviors to the effects of global warming. Much of the climate activism we see today is led by adolescents, who recognize the utmost importance of immediate action to mitigate the worst effects of climate change (UNDP, 2015; Han & Ahn, 2020; O'Brien et al., 2018). Despite these outspoken adolescent voices, there is still a pressing need for more climate-specific curricula targeted at educating youth in environmental science and engaging them in pro-environmental behaviors. One of the most achievable pro-environmental behaviors that adolescents can adopt is energy conservation at home (Han et al., 2022; Piscitelli & D'Uggento, 2022). A focus on energy conservation is especially relevant in the United States, which, despite comprising only 4% of the world's population, is responsible for 18% of global primary energy consumption, demonstrating the need for decreases in energy consumption nationwide (US EIA, 2021). In recognition of these needs, this research aims to understand whether engaging teenagers as energy stewards by increasing their knowledge about energy conservation actions can have an impact on other household members' awareness and motivation to conserve energy. This study presents the results of an experiment implemented to explore ways to support teenagers in becoming energy conservation stewards at home. The experiment included an online teaching module providing information about energy conservation, as well as guided activities to be conducted at home and in some cases with other household members.

Methods

Using a website as the experiment's online platform, we provided information about the contents of the program, and what participants could expect each week. The website also featured one motivational video intended to reinforce a social norm for energy conservation. The video describes why people should care about saving household energy to protect the environment and briefly describes a few conservation strategies that can help them do so to reinforce their self-efficacy and agency in the process. The video was also intended to motivate enrollment in the program and to establish clear outcome expectations.

The experiment was implemented among 106 households from elementary and middle schools in Los Angeles between the Fall of 2021 and the Winter of 2022. The households were divided into treatment and control groups and received the same information and instructions on how to conserve energy, but the information was presented in different ways. In the treatment group, teenagers were assigned an activity to be conducted at home, which in most cases involved interaction with their parents. Each week the activity focused on a different aspect of energy consumption at home, including air conditioning systems, lighting, kitchen, and showering. In the control group, we sent the same energy education material to the participating households, but in written form via email directly to the parents, without the inclusion of the teenagers in the household. Both groups received a weekly checklist to mark the energy-saving activities they had performed that week. These activities varied from simple things like turning off lights when

leaving a room to more complex tasks like changing thermostat settings. The checklist also collected information about weekly interactions between teenagers and parents, which allowed us to track their engagement with the experiment and any behavioral changes throughout the experiment. These changes were compared to the baseline responses from the entry survey, and later to the exit survey. The expectation was that households where teenagers report more frequent conversations with their parents about energy conservation would experience better engagement with the activities throughout the experiment and an increase in knowledge and awareness about energy efficiency at the end of the experiment.

Results

The entry survey responses corroborated that energy conservation knowledge is still limited. Before the experiment, only a small percentage of teenagers and parents participating in this study already knew how to reduce energy consumption, and less than half knew how to save water. At the end of the experiment, we found modest increases in knowledge scores among the majority of participants. We also found a modest increase in the average number of weekly energy-saving activities conducted, as compared to the entry survey responses. The types of activities they more frequently engaged in suggest that integrating activities related to existing routines, like brushing teeth, doing laundry, and showering, is easier than incorporating others that may be perceived as more difficult or time-consuming, such as air-drying utensils, air-drying clothes, and unplugging appliances, into their daily lives. We also found that continuous engagement with the activities is important, as those participants who stayed engaged throughout the six weeks of the experiment substantially outperformed the full group by completing most of the weekly activities.

The experiment shows a clear improvement in energy conservation awareness among parents and teenagers. Together with the results from the knowledge surveys, it appears that regardless of how much the participants improved the correctness of their knowledge answers, across the board, teenagers and parents left the experiment much more confident in their ability to conserve energy.

An important element of the experiment was to understand how often parents and teenagers discuss energy conservation and if there is any intergenerational learning (IGL), i.e., whether teenagers are transferring information to other members of the household. We did not find a strong correlation between the number of family conversations about the environment each week and the total number of energy-saving activities reported by parents in the same week. This suggests that contrary to expectations, engaging parents in more conversations with their teenagers about the environment does not affect their participation in energy-conserving activities. We found a slight reduction in the way parents see their children as having a decisive role in changing environmental behaviors at home, as compared to their responses in the entry survey. This could be due to a mismatch between their expectations before the experiment and the realization of how difficult these changes are to be implemented in real life. However, most parents changed their perceptions about the reliability of the information provided by their children in a positive way. While the frequency of conversations about the environment did not increase, parents reported that by the end of the experiment, their children tried more frequently to convince them to change their environmental behaviors. Taken together, these results provide

preliminary evidence supporting the idea that teenagers have the potential to be effective energy conservation stewards in their households.

When it came to actually implementing their children's suggestions, however, parents' responses were mixed. In particular, while teenagers made more frequent efforts to convince their parents to change their behaviors, this did not translate into increased implementation among all parents. Some even implemented fewer suggestions than previously, a sign of how difficult it can be to sustain energy conservation efforts over the course of several weeks. Overall, it seems that the parents became more aware of environmental problems and how challenging it is at the household level to implement conservation behavior. While the experiment led more parents to see their children as reliable sources of information, this did not directly translate into changes in environmental behaviors.

Conclusions

In conclusion, the results of this small experiment suggest that equipping teenagers with the knowledge and skills to reduce energy usage can lead to increased energy conservation awareness and concern among both teenagers and their parents. However, there were challenges in maintaining engagement with the program and measuring its impact on energy usage due to the small sample size, limitations associated with the Covid-19 pandemic, and the burden of data collection. The experiment also highlights the importance of linking energy-saving activities to existing routines and the potential benefits of investing in energy-efficient devices. To draw more definitive conclusions about the efficacy of the program, further research with larger sample sizes and more frequent feedback is needed.

2. INTRODUCTION

Background

Climate change and its effects on people, ecosystems, and society are widely considered one of the most pressing issues of our time (United Nations, n.d.). As the metaphorical clock ticks down to what many scientists have described as "the point of no return," (Latif, 2009; Van Zalinge et al., 2017); much emphasis is placed on the youth of today, and future generations, who will be forced to adapt their behaviors to the effects of global warming. Much of the climate activism we see today is led by adolescents, who recognize the utmost importance of immediate action to mitigate the worst effects of climate change (UNDP, 2015; Han & Ahn, 2020; O'Brien et al., 2018). Despite these outspoken adolescent voices, there is still a pressing need for more climate-specific curricula targeted at educating youth in environmental science and engaging them in pro-environmental behaviors. One of the most achievable pro-environmental behaviors that adolescents can adopt is energy conservation at home (Han et al., 2022; Piscitelli & D'Uggento, 2022). A focus on energy conservation is especially relevant in the United States, which, despite comprising only 4% of the world's population, is responsible for 18% of global primary energy consumption, demonstrating the need for decreases in energy consumption nationwide (US EIA, 2021). In recognition of these needs, this research aims to understand whether engaging teenagers as energy stewards by increasing their knowledge about energy conservation actions can have an impact on other household members' awareness and motivation to conserve energy. Teenagers represent about 13% of the total U.S. population and have the potential to exert a powerful collective drive toward environmental protection in society (Lee, 2008). Despite evidence of teenagers' support for environmental protection, little research has detailed how they might actively negotiate environmental issues with their families or exert actual influences on pro-environmental parental consumption (Collins, 2015; Stanes, Klocker & Gibson, 2015; Gentina & Muratore, 2012).

To fill up this gap, we developed an experiment to explore ways to support teenagers in becoming energy conservation stewards at home. The experiment included an online teaching module providing information about energy conservation, as well as guided activities to be conducted at home.

Research shows that households still have little knowledge about appliance-level energy use. For example, the majority of households overestimate the amount of energy used by lighting and underestimate the amount used by heating and cooling (Asensio & Delmas, 2015; Delmas & Lessem, 2014). The online teaching module provided information about energy use at the appliance level, energy conservation strategies, and tactics that teenagers could use to encourage their parents to conserve energy at home.

The online teaching module included an educational video, interactive activities, and quizzes to assess teenagers' knowledge of energy efficiency. As a take-home exercise, teenagers implemented some of the conservation persuasion tips provided in the video while implementing energy reduction strategies with their parents. Both parents and teenagers were required to fill out an energy use questionnaire after each activity and a weekly checklist to report on their progress.

The results of these experiments show a slight increase in knowledge and awareness of energy conservation at home, and a modest increase in the number of energy conservation activities

performed weekly. Both parents and teenagers reported an increase in their self-perceived agency to reduce energy consumption at home. Parents viewed their children as more reliable sources of information after the experiment but reported less confidence in their children's ability to change energy conservation behaviors at home at the end of the experiment. This reflected how the activities seemed to make participants more aware of how difficult it is to change other people's behavior toward energy conservation. Furthermore, while the participants initially indicated their willingness to conduct conservation behavior, we find that over time, they became less engaged. Parents ultimately completed more energy conversation activities than teenagers, possibly because they were motivated to get the household involved in bonding activities assigned by their teenagers' schools. It may be the case that parents are the ones trying to get their teenagers more involved in the family during a time when they may be relatively less communicative at home and spend more time socializing with friends.

These results provide insights into the challenges associated with energy conservation behavior in the home. Specifically, it may be less effective to recommend energy conservation tasks that require individuals to go out of their way, such as air-drying utensils if they are accustomed to using a dishwasher. Instead, individuals tend to be better at integrating activities that are linked to daily or weekly routines, such as shortening the duration of their showers, using cold water settings when doing laundry, and turning off the faucet when brushing their teeth.

Previous work

Many researchers recognize the importance of equipping youth with knowledge on climate change mitigation behaviors, and there is robust research on how to educate and engage people in such matters (Boudet et al., 2016; Lawson et al., 2019a). Our study finds its theoretical foundations in social cognitive theory (SCT), which posits that behavioral change is driven by a multitude of determinants, with primacy placed on self-efficacy, one's subjective belief in their capabilities to perform a task (Bandura, 1985). Another relevant determinant as described by SCT is one's outcome expectations of a certain behavioral change. A large portion of this has to do with how socially desirable one perceives their potential behavioral change to be and how the members of their social environment will react to their behavioral change (Bandura, 1985). SCT has been applied successfully in an adolescent energy conservation behavior change intervention of Girl Scout troops in California (Boudet et al., 2016). The experiment reported significant behavioral changes in both the Girl Scouts and their parents, especially when it came to residential energy usage (Boudet et al., 2016). This study is relevant to our research because it provides a reference for incorporating the principles of SCT into a youth-targeted energy intervention that also addresses its potential effects on their parents.

By and large, most of the studies in this field have found that an increase in knowledge about climate change does not, on its own, correlate with a change in pro-environmental behavior (Alcott, 2011; Asensio et al., 2013; Costa & Khan, 2013). A key factor discussed is the importance of worldview in shaping climate-related behaviors. The behaviors of individuals are more influenced by their worldviews and personal ideologies (whether political, societal, or environmental) than by the knowledge they have of climate change (Libarkin et al., 2018). This indicates that interventions designed to modify energy usage behaviors should not rely solely on increasing the participants' knowledge. However, it has also been shown that adolescents across ideologies and worldviews are more open than adults to learning about how they can act on

climate change and adjust their behaviors (Stevenson et al., 2018). This research highlights the importance of targeting adolescents with energy conservation programs, as they are more likely than adults to be receptive to the messaging of the intervention, regardless of their worldviews.

An important aspect of the formation of worldviews comes from peer-to-peer communication, through which youth are exposed to the social norms of their immediate environment. Youth are more likely to change their behaviors after being surrounded by pro-environmental social norms rather than solely through climate-specific education (Busch et al., 2019). Although pro-environmental social norms necessitate knowledge of climate change itself, it is important to be cognizant of what to include in climate educational messaging to maximize behavioral change (Busch et al., 2019). A combination of consistent descriptive and injunctive information on individuals' energy usage is effective in changing energy usage (Bonan et al., 2020). These messaging tactics are especially useful for individuals whose energy usage is furthest from the norm, as they are motivated to change to adhere to the consumption standard of their communities (Bonan et al. 2020).

By equipping adolescents with knowledge and actionable behavioral changes, it is also possible to reach and potentially alter the behaviors of the adults in their lives, like their parents. Promoting energy-related conversations at home between parents and their children can promote action from children, even when parents themselves are indifferent about energy efficiency or climate change (Lawson et al., 2019b). Therefore, an intervention focused on educating adolescents about energy efficiency to modify their behaviors should incorporate the other important people in a child's life, like their parents, into the intervention to maximize results. Interventions should utilize strategic framing of issues to make use of the unique intergenerational relationship between children and their parents. This can be done by incorporating interventions such as explaining issues within local contexts, engaging children with hands-on learning activities, and instructing children to have family discussions about energy consumption (Lawson et al., 2019).

While these findings are robust, there are still gaps in this area of research. Specifically, it is unclear how intergenerational relationships between children and adults can be used as a conduit to motivate older adults to change their energy conservation behaviors, especially those who may be less open to change than adolescents who are still forming their worldviews.

Our research seeks to fill this gap by investigating whether: (a) equipping children with the knowledge and skills to reduce energy usage at home, and (b) asking them to discuss what they learn with their families will result in increases in concern, awareness, and motivation for saving energy. We hope that such programs can empower youth to become energy conservation stewards in their communities and take care of the planet.

3. METHOD

Participants

The participants in this field experiment are teenagers and their parents from elementary and middle schools in Los Angeles. The first version of this study was conducted over 3 months in the Fall of 2021 at an elementary school with 67 participating households; 42 were in the treatment group, and the remaining 25 were in the control group. Out of these 67 households, 42

effectively participated in the experiment when it started; i.e. they completed the initial baseline surveys and activities. A second version was conducted in the Winter of 2022 at a middle school with 39 participating households; 12 were in the treatment group and 27 were in the control group. Out of these 39 households, 8 ultimately participated in the rest of the activities. In total, 106 households from the two pilots were recruited to the study, and 50 of them ended up completing the activities.

Our goal in this research is to evaluate the impact of participation in the experiment on attitudinal and behavioral changes regarding energy consumption at home. If participants in the treatment group exhibit increases in energy conservation awareness and motivation for saving energy, this may corroborate predictions of behavior change by the social cognitive theory (Bandura, 1985),**Error! Bookmark not defined.** supporting the hypothesis that energy conservation education should focus on both motivation and implementation strategies to be effective.

We also expect to see results based on the number of interactions between teenagers and parents. We expect that in households where teenagers report more frequent conversations with their parents about energy conservation to eventually experience better engagement with the activities throughout the experiment and an increase in knowledge and awareness about energy efficiency.

Procedures

Each of the experimental interventions lasted for six weeks and was implemented with two randomly assigned participant groups. Before the start of the experiment, all participants, including teenagers and their parents, received the same entry surveys with questions assessing their energy conservation knowledge, awareness, and motivation for conserving energy, and questions about their perceived abilities to accomplish this (self-efficacy). We measured the extent to which participants consider energy conservation as important, valuable, and achievable through Likert scale questions ranging from "strongly disagree" to "strongly agree." We also asked whether they considered their community to be energy-conscious and whether they were expected to conserve energy to gauge the extent of existing social norms around them. While we would have liked to measure actual energy consumption changes through utility bills, we were not able to obtain them from the utility companies. Instead of this, we asked parents to upload photos of their energy bills onto the same online platform. Due to the limited number of uploads received, we did not include them in our analysis.

During the interventions at both schools, the treatment and control groups received the same information and instructions on how to conserve energy. In the treatment group, teenagers were assigned an activity to be conducted at home, which in most cases involved interaction with their parents. Each week the activity focused on a different aspect of energy consumption at home, including air conditioning systems, lighting, kitchen, and showering. We selected these areas of energy consumption based on the U.S. Energy Information Administration's data, which showed that they represent a large portion of household energy consumption (US EIA, 2021). For each activity, participants watched an energy conservation video that encouraged and taught behavior change related to energy use, to provide knowledge and establish specific outcome expectations. After watching the video, they were instructed to have conversations with their parents about what they had learned and how to implement the conservation strategies together. At the end of the activity, they reported their results by answering a few questions.

In the control group, we sent the same energy education material contained in the videos to the participating households, but in written form via email directly to the parents. Teenagers in the control group did not receive any conservation-related information, and neither the parents nor the teenagers in the control group were asked to have conservation-related conversations with each other (see Figure 1).

Both groups received a weekly checklist to mark the energy-saving activities they had performed that week. These activities varied from simple things like turning off lights when leaving a room to more complex tasks like changing thermostat settings. The checklist also collected information about weekly interactions between teenagers and parents, which allowed us to track their engagement with the experiment and any behavioral changes throughout the experiment. The complete checklist can be found in Appendix A.

Figure 1
Treatment and Control groups

Treatment group	Control group
Parents consent and teenagers assent to participate in the program. Parents complete entry and exit surveys and participate with their children in weekly activities. Teenagers complete entry and exit surveys and receive weekly emails to complete activities and checklists. Teenagers have a weekly check-in meeting with teachers and researchers.	Parents consent and teenagers assent to participate in the program. Only parents complete entry and exit surveys and receive the same information about weekly activities as that sent to the control group (without needing to complete them). Teenagers in the control group do not receive any information (or activities).

Communication between teachers and teenagers in each group also varied. In the treatment group of the first experiment at the elementary school, teachers and teenagers participated in weekly check-in meetings designed to gauge student engagement with and understanding of the weekly activities. As we can discern from the results, these meetings also helped motivate teenagers to continue participating in the study because the teachers leading the discussion were a more central force than researchers in encouraging continued student participation and promoting the social desirability required for changing behavior. Researchers only participated in these weekly meetings as observers and did not interact with the teenagers. For teachers in the control group, we instructed them to avoid discussing the experiment with anyone, including other teachers and participants.

The study design differed slightly at the middle school site due in part to the structure of the school itself. Control and treatment groups were randomized by grade instead of the classroom,

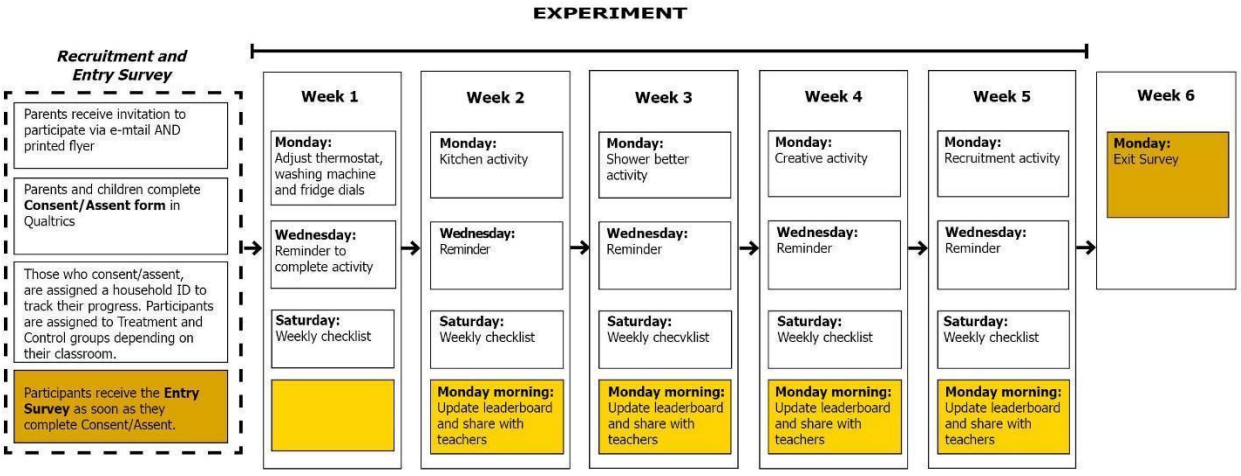
and unlike at the elementary school, there was no integration of the teachers into the experiment. In the treatment group at the middle school, parents received only the pre-and post-surveys, rather than all the conservation-related information. The teenagers in the treatment group received weekly activities in addition to the pre-and post-surveys. In the control group, only the parents received the pre-and post-surveys and weekly emails with conservation information that was much briefer and less involved than the material provided to the treatment group.

Information Material

The information material was distributed using a website that served as an online platform. The website provided information about the intervention program, its contents, and what participants could expect each week (see Appendix B for further information about the website). The website also featured one motivational video (See figure B2) intended to reinforce a social norm for energy conservation. The video describes why people should care about saving household energy to protect the environment and briefly describes a few conservation strategies that can help them do so to reinforce their self-efficacy and agency in the process. The video was intended to motivate enrollment in the program and to establish clear outcome expectations.

At the beginning of each of the six weeks of the intervention, participants received an email with a link to a Qualtrics survey, where they were given instructions to complete that week's activity. For the treatment group, each activity included one instructional video that focused on energy conservation strategies with the refrigerator, water heater, and air conditioner. The purpose of these videos was to boost teenagers' confidence in their abilities to make a difference through their advocacies for their parents and their behavior changes. All the videos were presented in animations and storylines that appeal to the specific age group of teenagers. After the activity, participants were asked a few questions regarding what they did during the activity. The activities conducted each week are illustrated in Figure 2 below, and a more detailed description of the weekly activities can be found in Appendix C.

Figure 2
Experiment Timeline



At the end of each week, participants received another email with a link to complete a weekly checklist, intended to be a quick check-in where they could track the energy-saving activities that they completed that week (see Appendix A)

At the end of the experiment, teenagers could request an online certificate of completion from the Dial Down website (included in Appendix D). This certificate was intended to motivate teenagers to remain engaged throughout the duration of the experiment and could be used by them to demonstrate to others their commitment to sustainability and energy conservation.

4. RESULTS

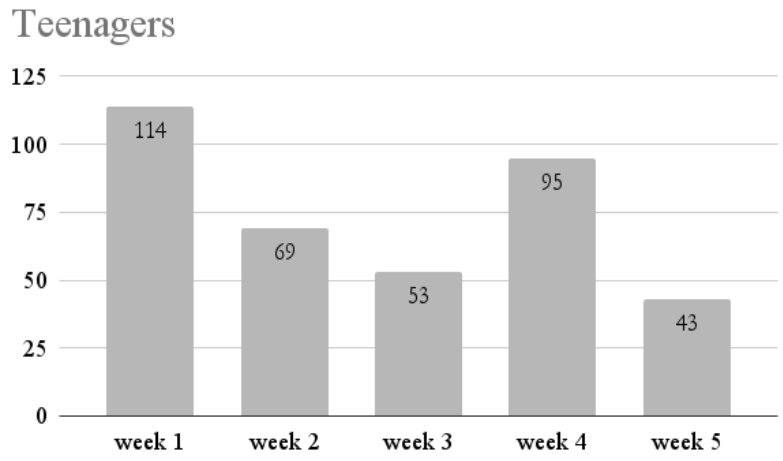
It should be noted that the following discussion of results from the program at these schools is based on a very small sample size and is not representative of Los Angeles or California. However, the findings from these experiments provide a relevant foundation for understanding the impact and efficacy of such programs.

Demographics and household characteristics of the participants.

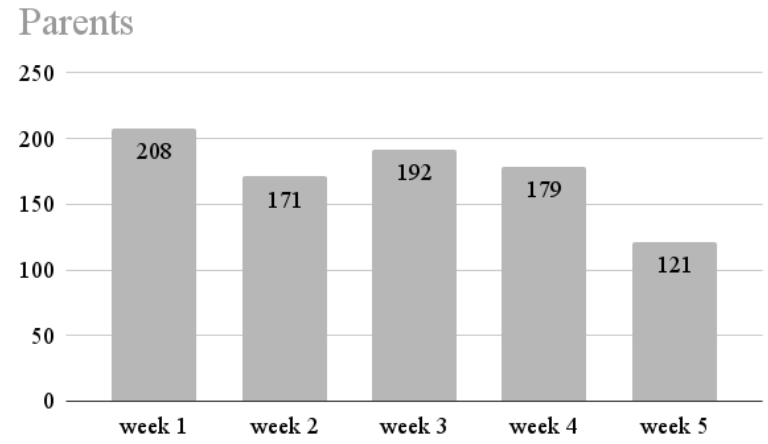
The median household size was four people, with a minimum of two and a maximum of five people per household. The majority of the participants (70%) had a median household income in the upper range of $225,000 and more and tended to live in larger housing units that they owned, rather than rented (only 11% lived in a unit of 1,200 s.f. or less). The parents in the sample were mostly white, college-educated, and tended to vote Democrat. The average age among parents in the sample was 50 years old. The gender of the parents in the sample was evenly split, with 50% females and 50% males. For further details, see Table E1 in Appendix E.

Energy saving activities. More parents than teenagers reported conducting energy-saving activities over the course of the experiment, as can be seen in Figure 3. This is contrary to our expectation that teenagers would conduct more activities since they were the direct recipients of the information and instructions. Figure 3 also illustrates how the total amount of energy-saving activities conducted fell each week across both parents and teenagers. In the first week, parents engaged in 208 energy-saving activities while teenagers engaged in 114 activities. By the fifth week, the number of activities conducted dropped to 121 and 43, respectively.

Figure 3
Total number of energy-saving activities conducted per participant



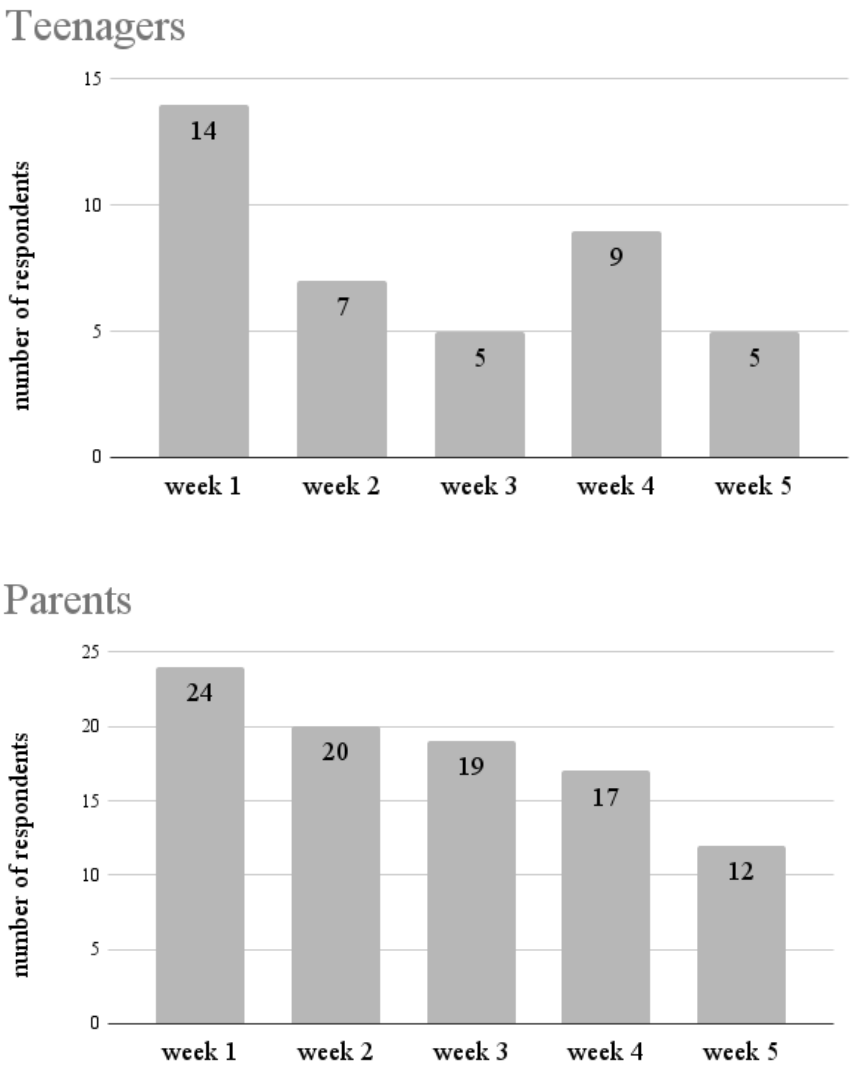
Note: The total number of teenagers at the beginning of the experiment was 14.



Note: The total number of teenagers at the beginning of the experiment was 14.

It should be noted that this overall decrease in energy-conservation activities was also coupled with an overall decrease in both parent and teenagers' participation in completing the weekly checklist, as seen in Figure 4. When looking at the average number of weekly energy-saving activities conducted, there are modest increases for both parents and teenagers. See Table F1, Figure F1, and F2 in Appendix F for further details.

Figure 4
Total number of checklist respondents, per week



Parents and teenagers tended to complete similar activities. See Appendix Figures G2 and G3. The results suggest that integrating activities related to existing routines, like brushing teeth, doing laundry, and showering, is easier than incorporating others, such as air-drying utensils, clothes, and unplugging appliances, into their daily lives.

Appendix Figure G4 illustrates the selection effect of parents who stayed through the end of the experiment. These participants were much more likely to complete most of the activities, compared to the full sample at the beginning of the experiment. In other words, those who stayed until the end substantially outperformed the full group.

There is not a strong correlation between the number of family conversations about the environment each week and the total number of checklist activities completed by parents in the same week, as shown in Appendix Table G1. This suggests that contrary to expectations, engaging parents in more conversations with their teenagers about the environment does not affect their participation in energy-conserving activities. Interestingly, while the correlation is small and negative in the first week, it becomes positive in the second and third weeks, albeit smaller in magnitude, before dropping to close to zero in the last two weeks. This suggests evidence of attrition after the first week: those who stay in the experiment are more likely to have more family conversations about the environment and complete more checklist activities. See Appendix Figure G4 for details.

Energy conservation knowledge. We measured participants' knowledge about energy conservation by tracking the percentage of correct answers to eight questions presented in the entry survey they completed before the start of the experiment (see Table 1). These baseline responses reflect that only a small percentage of teenagers and parents in the sample already knew how to conserve energy at home. In particular, only 7% of teenagers and 16% of parents knew the percentage reduction in costs from cutting back on heater usage. Only 13% of teenagers and parents knew the recommended setting for the air conditioning thermostat in the summer months in California. While a larger percentage of teens and their parents had the correct baseline knowledge about how to save water, it is still less than half the sample, at 40% and 41% respectively.

We were able to match these responses with post-survey responses for some respondents. We found increases in the percentage of participants who correctly answered most of the questions, with the question "If you set back your temperature 7-10 degrees Fahrenheit for 8 hours a day during a month, how much does it lower your heating costs (in percentages)?" receiving the least correct answers.

We were able to compare the pre-and post-survey responses from the parents, but not the teenagers, due to the low response rate post-experiment (see Table F2 in Appendix F for the teenagers' responses). When comparing the knowledge responses after the experiment to those before the experiment, we found that parents substantially changed their estimates for the percentage of electricity usage that comes from different sources. Initially, they tended to overestimate the percentage of electricity originating from overhead lighting and appliances plugged into electric outlets, with answers ranging between 16.7 and 18.9% and 24 and 23% respectively, when the national average is 4 percent for overhead lighting and 17% for appliances plugged into electric outlets (US EIA, 2021). **Error! Bookmark not defined.** Similarly, respondents also tended to overestimate the percentage of electricity originating from the refrigerator, averaging 17% and 13% when the national average is 7%. Participants also overestimated the energy required for water heating, averaging 15% to 19% when the national average is 12%. In contrast, respondents tended to underestimate the electricity used for space heating and cooling, with answers averaging 26% when the national average is 33% (US EIA, 2021). **Error! Bookmark not defined.** Even when their estimates are off, the ranking of electricity usage is somewhat accurate. All participants correctly estimated space heating and cooling as the highest consumer of electricity at home.

Table 1
Pre-survey knowledge responses, parents and teenagers

	Teenagers	Parents
	Mean (s.d.)	Mean (s.d.)
Question	Base	Base
What percentage of your electricity usage do you estimate coming from:	*N* = 15	*N* = 30
Overhead lighting	18.9	16.7
	(12.8)	(9.9)
Space heating and cooling	26.1	26.8
	(18.8)	(16.6)
Appliances plugged into electric outlets	23	24.3
	(16)	(15.2)
Water heating	19	15.2
	(13.6)	(12.6)
Refrigerator	13	17
	(6.2)	(11.7)
If you set back your temperature to 7-10 degrees Fahrenheit for 8 hours a day during a month, how much does it lower your heating costs? (estimated percentage of the monthly cost) (correct answer: 10%)	7% answered correctly	16% answered correctly
What is the recommended setting for your air conditioning thermostat in the summer months in California if you want to be comfortable but save energy too? (correct answer: 78F)	13% answered correctly	13% answered correctly
On average, how many gallons of water can you save by reducing the time you shower from 10 minutes to 5 minutes? (correct answers: 6-8 or 9-12 ga)	40% answered correctly	41% answered correctly
T/F: The refrigerator temperature for optimal energy performance is about 36.5 F (correct answer: True)	87% answered correctly	58% answered correctly
T/F: Refrigerators run more efficiently when they're almost empty (correct answer: False)	60% answered correctly	74% answered correctly
T/F: A fridge in a warm garage (about 90F) will consume up to 50% more energy than one placed inside a cooler indoor area (correct answer: True)	87% answered correctly	80% answered correctly
T/F: It's OK to open the fridge many times, as long as you do it quickly (correct answer: False)	80% answered correctly	87% answered correctly

In the post-survey, parents adjusted their answers. For seven out of eight parents, the knowledge scores increased, suggesting an improvement in their knowledge. Notably, the dispersion in their answers decreased substantially: in the baseline estimates for the percentage of electricity coming from appliances, the responses ranged from 5% to 70%. After the experiment, it narrowed to 10% to 50%, which is still large but indicates potential improvement in knowledge. Those who underestimated their baseline responses adjusted by increasing their estimate the second time around, shifting slightly toward a more correct answer. Similarly, those who overestimated (e.g. the ones who guessed closer to 70% in the baseline) adjusted their answers downwards to a more correct estimate after the experiment. For other categories, however, like space heating and water heating, a reduction in dispersion did not correspond to more correct answers. For both of these categories, the baseline estimates were more correct than the ones after the experiment. Overall, the results for knowledge questions were mixed among parents.

Self-perceived energy conservation ability

Next, we analyze responses about participants' awareness of electricity conservation. Most notably, teenagers' responses to "I know how to achieve the maximum reduction in electricity consumption at home" increased from "definitely not" and "probably not" to "probably yes" and "definitely yes," indicating a clear improvement in this particular measure of energy conservation awareness. This was also the case among parents: while they did not change their answers drastically for almost all of the awareness statements, the only one that reflected substantial change was "I know how to achieve the maximum reduction in electricity consumption at home" (see Table F3 and F4 in Appendix F). Considering this together with the results from the knowledge surveys, it appears that regardless of how much they improved the correctness of their knowledge answers, across the board, teenagers and parents left the experiment much more confident in their ability to conserve energy.

Intergenerational learning or interaction between parents and teenagers

An important element of the experiment was to understand how often parents and teenagers discuss energy conservation and if there is any intergenerational learning (IGL), i.e., whether teenagers are transferring information to other members of the household. However, we found that parents' IGL results were mixed as shown in Table 2. For example, in the question "Do you see your child as having a decisive role in changing environmental behaviors in your household?", almost half of the parents adjusted their responses downwards (e.g. from "probably yes" to "probably no"). This could be due to a mismatch between their expectations before the experiment and the realization of how difficult these changes are to be implemented in real life.

Regarding the question "Do you see your child as a reliable source of information?" 13% of parents answered "definitely not" in the pre-survey, while in the post-survey, every parent answered "probably yes" or "definitely yes," indicating a potential change in their attitudes toward the information that children can provide them. However, no one reported any increase in the frequency of conversations about the environment. So, while parents' attitudes may have changed, household behaviors did not.

Instead, parents reported that by the end of the experiment, their children tried more frequently to convince them to change their environmental behaviors. Taken together, these results provide

preliminary evidence supporting the idea that teenagers have the potential to be effective energy conservation stewards in their households.

When it came to actually implementing their children's suggestions, however, parents' responses were mixed. In particular, while teenagers made more frequent efforts to convince their parents to change their behaviors, this did not translate into increased implementation among all parents. Some even implemented fewer suggestions than previously, a sign of how difficult it can be to sustain energy conservation efforts over the course of several weeks.

Overall, it seems that the parents became more aware of environmental problems and how challenging it is at the household level to implement conservation behavior. While the experiment led more parents to see their children as reliable sources of information, this did not directly translate into changes in environmental behaviors.

Table 2

Parents' IGL responses, pre- and post-surveys

Questions:	Pre-survey Mean (s.d.) Base $N = 8$	Post-survey Mean (s.d.) Base $N = 8$
Do you see your child as having a decisive role in changing environmental behaviors in your household? [1]	4.1 (0.82)	3.9 (1.2)
Do you see your child as a reliable source of information?[1]	4.1 (1.01)	4.3 (0.46)
How often do you talk about the environment with your children? [2]	3.6 (1.5)	3.4 (0.9)
How often do you start these conversations?[2]	3.5 (1.9)	3.3 (1.0)
How often have your children tried to convince you to change your environmental behaviors?[3]	2.4 (1.06)	2.9 (1.1)
Have you implemented any of their suggestions?[4]	3.8 (1.3)	3.8 (1.5)

Answers to the questions:

[1] Definitely not, 2: Probably not, 3: Might or might not, 4: Probably yes, 5: Definitely yes

[2] Never, 2: Once a month, 3: Once a week, 4: 2-3 times a week, 5: Daily

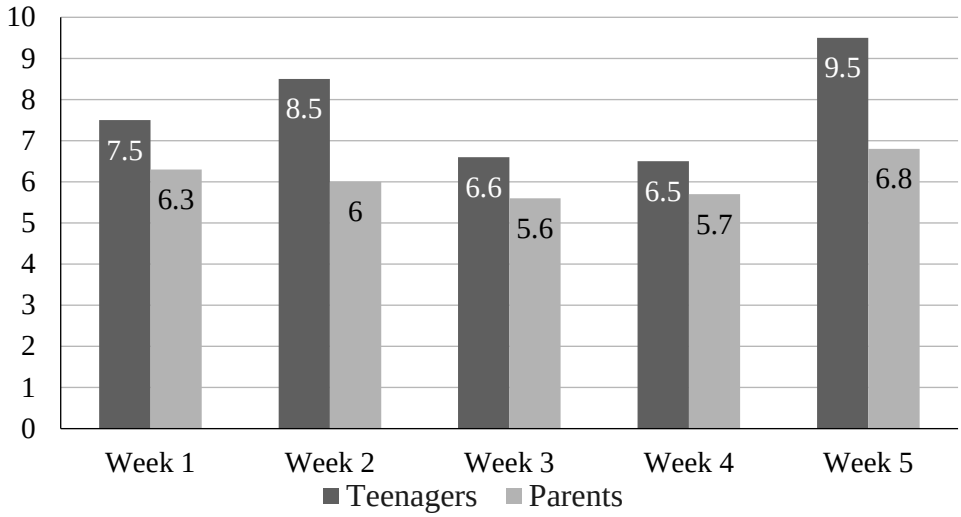
[3] Never, 2: Rarely, 3: A few times, 4: Often, 5: Very often

[4] None at all, 2: Few of them, 3: Some of them, 4: Most of them, 5: All of them

We also found that teenagers reported having more conversations per week than their parents (see Figure 5). The teenagers reported about 7.5 conversations per week and the parents 6 per week. The question asked about the number of conversations with other family members, so we assume teenagers were conducting these conversations not only with their parents.

Figure 5

Average number of family conversations about the environment per week, teenagers' vs parents' responses



5. DISCUSSION

One of the goals of this research was to understand whether knowledge about energy use and motivation for saving energy at the household level could be promoted by equipping teenagers with the knowledge to reduce energy usage and skills to convince their household members. We asked teenagers to complete a series of weekly activities and then discuss what they learned with their families.

Overall, we find that both teens and their parents had minimal prior knowledge of how to conserve energy at home. At the end of the experiment, parents increased their awareness of environmental issues as well as their knowledge of energy consumption. For all questions, there was an increase in energy conservation awareness concern (reducing electricity consumption is important and valuable to me, and learning to reduce electricity consumption is useful to me) and an increased perception of their agency to achieve energy efficiency at home. Parents also reported conducting more saving energy-saving activities on the weekly checklists. However, their results were not reflected in their knowledge scores, and we were not able to measure if an increase in agency had an impact on energy usage due to the lack of energy utility bills we were able to collect from the participants. Although the results are smaller in scale, they point to the potential of programs to promote intergenerational learning among household members to change energy usage awareness and behaviors at home.

In terms of engagement with the weekly activities, parents tended to maintain the same number of activities in weeks two through five, while there was much more fluctuation among teenagers. The number of parents who completed weekly activities was also more stable, whereas there was already a sharp reduction in the number of teens completing activities in week two.

The types of activities completed by parents and teenagers were similar, and indicate that those linked to existing routines, such as brushing teeth, doing laundry, and showering, are easier to incorporate into their daily lives than others, such as air-drying utensils, air-drying clothes, and unplugging appliances. It may be more effective for parents to invest in energy-efficient home devices, such as motion sensor lights, or door-opening dishwashers that use less heat during the drying cycle. In addition, the results indicate that participants become more motivated to conserve energy, but they lack sufficient information on the exact impact of their energy conservation behavior. Frequent feedback could help parents and their teenagers adjust their energy conservation behavior appropriately: they might be more likely to conserve electricity and water basis regularly if they are aware of the weekly impact it has on their overall energy consumption and ultimately, on their utility costs.

We found that while teens reported having more conversations about the environment with their families, parents did not. It is therefore unclear whether the experiment caused an increase in household conversations about energy conservation and the environment.

The baseline responses of both teenagers and parents indicated more optimism and confidence in teenagers' abilities to change household behaviors around conserving energy compared to their responses at the end of the experiment. This is particularly reflected in the way parents adjusted their intergenerational learning responses. While many parents started the experiment believing their teenagers would be effective at changing household energy conservation behavior, they no longer maintained this belief by the end. We infer that after completing the activities, parents realized how difficult is to implement these changes daily. However, the majority increased their perception of the reliability of the information teenagers may provide to the household. This presents the potential of equipping teenagers with energy or other conservation information that can be transferred to other household members.

However, our experiment included only a small number of participants, which limit the generalization of our results. This is partly due to some of the challenges associated with the Covid-19 pandemic during the experiment, particularly in-person interactions. The experiment was conducted during the fall of 2021 and winter of 2022 when some Covid-19 restrictions were still in place, and when teenagers and teachers were transitioning from online learning back into the classrooms. This made it difficult for us to interact in-person with the teachers within the schools and may have contributed to the low participation in both schools.

While the experiment was designed with minimal interaction with the teachers, with the intention of not disrupting their curriculum and complying with the Covid-19 pandemic restrictions, we noticed higher levels of engagement with the teenagers in the elementary school, where teachers and researchers conducted a weekly 10-minute check-in to discuss the activities of the experiment. In contrast, this type of collaboration was not possible at the middle school, and we found a lower level of student engagement there, even though parent participation was higher. We foresee that incorporating an element of supervision or guidance by teachers or classroom leaders could increase motivation, participation, and program permanence.

Covid-19 may have had a confounding effect on the experiment due to participants spending all their time at home. Parents may have been incentivized to moderate their energy usage under these circumstances, and as a result, were more likely to participate in energy conservation activities. The experiment also served as a way for parents to be more involved in their teenagers'

schoolwork during a time when they were navigating the challenges of transitioning to online learning.

We also recognize that this type of experiment may benefit from the use of incentives to secure the continuity of the participants. In this case, the elementary school had specific guidelines against competition or incentives, so we could not use them. However, similar experiments have been able to use incentives to successfully promote participation over time. These can be in the form of normative pressure applied by the school or the teenagers, or social gathering incentives that are common in the educational system, such as pizza or ice cream parties.

Another challenge is related to the nature of the data we are asking from participants. We asked them to take a picture and upload their utility bills to the platform, which may be time-consuming or seem burdensome for some, while for others it may seem like an intrusion into their private information. This fact prevented us from measuring changes in electricity consumption, which could have provided more tangible information about the effects of this experiment on electricity usage.

Lastly, the implementation of this experiment at a larger scale (a larger school or several schools) would help to obtain a larger dataset for statistical analysis. A key factor continues to be the engagement with participants, to ensure that they complete all the activities in the program.

Overall, the results from this small experiment show the potential of a program like the Dial Down Challenge to increase knowledge surrounding energy consumption at home. However, the small sample size limits the generalizability of the results. To obtain sufficient data for statistical analysis and draw valid conclusions about the program's efficacy, implementation on a larger scale, such as in a larger school or multiple schools, is needed. Engaging participants and ensuring they complete all program activities remain critical factors. These results underscore the challenges of modifying household behavior, especially when activities are not linked to existing routines such as brushing teeth or doing laundry. Investing in energy-efficient devices such as smart-home thermostats, LED lightbulbs, and dishwashers with automated door-opening for drying may be more effective for households. Future research on energy conservation behavior could include more frequent feedback to show participants the impact of their actions and help them understand how much they could save on their utility costs.

6. CONCLUSION

In conclusion, the results of this small experiment suggest that equipping teenagers with the knowledge and skills to reduce energy usage can lead to increased energy conservation awareness and concern among both teenagers and their parents. However, there were challenges in maintaining engagement with the program and measuring its impact on energy usage due to the small sample size, limitations associated with the Covid-19 pandemic, and the burden of data collection. The experiment also highlights the importance of linking energy-saving activities to existing routines and the potential benefits of investing in energy-efficient devices. To draw more definitive conclusions about the efficacy of the program, further research with larger sample sizes and more frequent feedback is needed.

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8. APPENDIX A

Weekly checklist

Check the activities you have completed since you started the Dial Down Challenge (you can check more than one):

- ☐ Turned off the lights every time you left the room
- ☐ Used natural lighting during the day
- ☐ Unplugged appliances and electronics when you were not using them
- ☐ Used cold water to brush teeth and wash hands
- ☐ Turned off water while lathering, shaving or brushing teeth
- ☐ Lowered monitor brightness
- ☐ Used table lamp instead of ceiling lights
- ☐ Used cold water to wash laundry
- ☐ Ran a full load of laundry
- ☐ Used a microwave, crock pot, or a toaster oven instead of a conventional oven
- ☐ Air dried utensils instead of heat dry in the dishwasher
- ☐ Air dried clothes
- ☐ Turned off A/C when not at home
- ☐ Took a shorter shower than usual
- ☐ Talked about the Dial Down Challenge activities with family members
- ☐ None of the above

9. APPENDIX B

Figure B1
Dial Down Challenge's website landing page

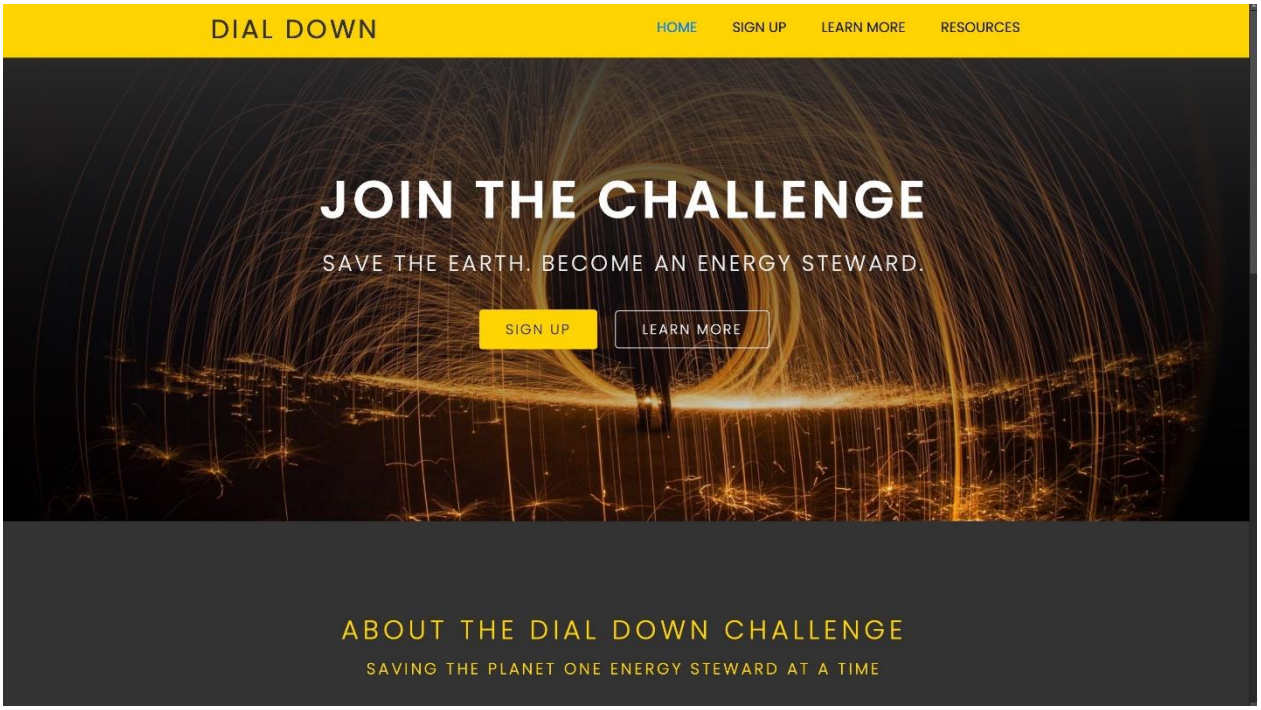
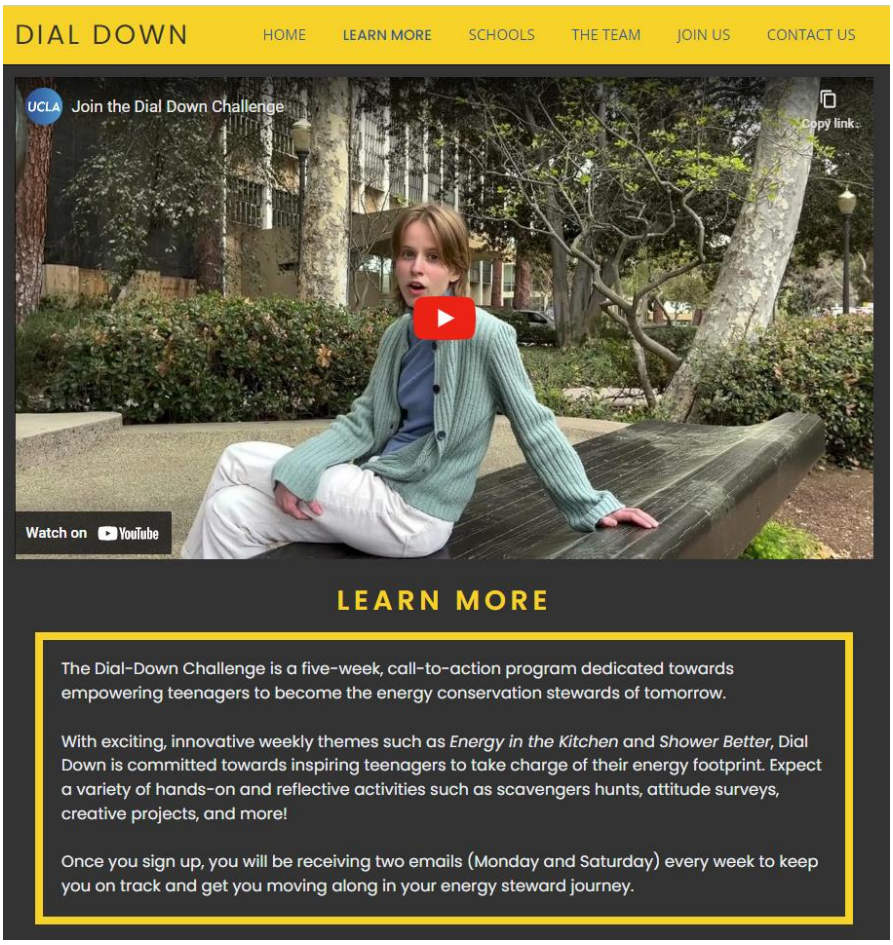


Figure B2

Dial Down Challenge's website, "Learn more" page with motivational video[1]



[1] The video can be found here: https://youtu.be/TbWLQs5r_CI

10. APPENDIX C

Weekly activities

Recruitment (Week 0) – At the participating school, teachers promote the experiment via flyers and information to the teenagers.

Teachers send parents an email with an invitation to participate in the experiment. The email includes a link for parents and teenagers to complete the consent/assent forms.

As soon as consent/assent forms are completed, participants receive the entry survey (pre-survey), and are assigned to the treatment or control groups. A household identification number (HH_ID) is assigned to all participants.

Week 1 – Dial it down! On Monday, participants receive an email with a link to complete the weekly activity. The first activity consists of adjusting their home air conditioning thermostat and refrigerator settings. They also receive information to reduce electricity usage while using their washing machines.

On Saturday, participants receive an email with a link to complete the weekly checklist (see Appendix A).

Week 2 – Energy in the Kitchen. On Monday, participants receive an email with a link to complete the weekly activity. The second activity includes information to save energy while cooking and doing dishes. The kitchen activity is intended to be completed with the whole family.

On Saturday, participants receive an email with a link to complete the weekly checklist.

Week 3 – Shower better. On Monday, participants receive an email with a link to complete the weekly activity. The third activity includes information to save water and energy while taking a shower.

On Saturday, participants receive an email with a link to complete the weekly checklist.

Week 4 – Creative activity. On Monday, participants receive an email with a link to complete the weekly activity. The fourth activity is a creative project, where participants can create a poem, drawing, picture or video where they express what they have learned so far in the experiment.

On Saturday, participants receive an email with a link to complete the weekly checklist.

Week 5 – Recruitment activity. On Monday, participants receive an email with a link to complete the weekly activity. The fifth and last activity is a recruitment activity, where participants are required to talk to other people about the project and convince them to enroll in future experiments. Participants collect their contact information and share it with the research team.

On Saturday, participants receive an email with a link to complete the weekly checklist.

Week 6 – On Monday, participants receive an email with a link to complete the exit survey (post-survey).

Week 1 – Dial it down!

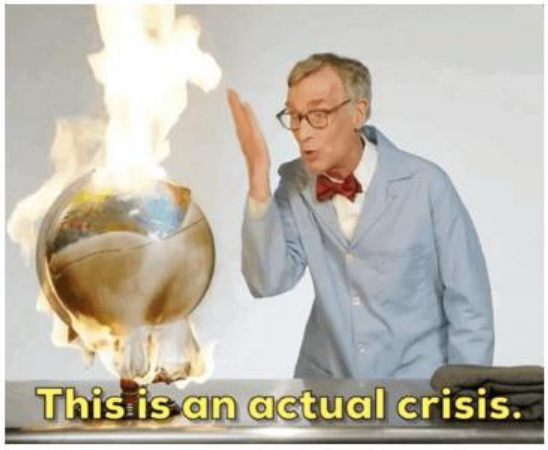
Week 1 | Dial it down!

Hi Energy Stewards!

In this activity, we will turn down the A/C and fridge dials to save both energy and money in your household. This activity will take 10 - 15 minutes.

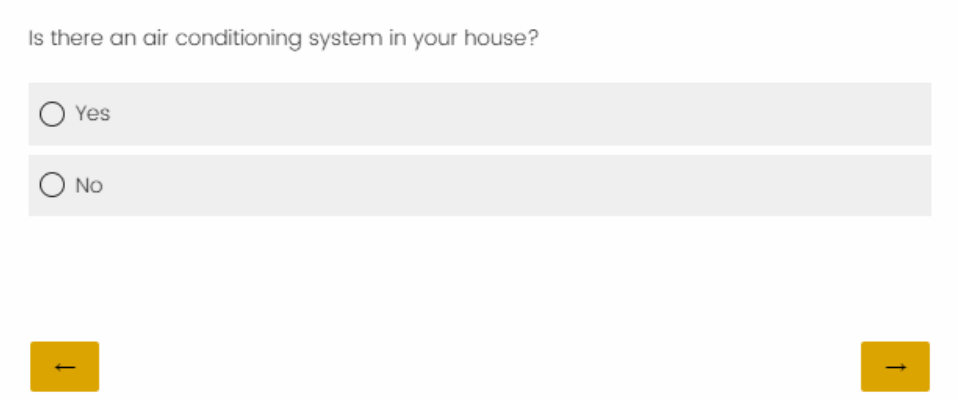
Let's start with your air conditioning system. Heating and cooling can account for up to 30% of household energy use. By simply changing the temperature on your thermostat 7 - 10°F for 8 hours a day, you may save up to 10% yearly on your energy bill. This also means you will be using much less energy and will be taking much needed steps to curb the effects of climate change.

We will be giving you and your family step-by-step instructions on how to reduce your dependence on the thermostat. Make sure you discuss with them these changes.



Link to video: https://www.youtube.com/watch?v=lL4U3EY1VmQ

US DOE Energy Saver: Setting Your Thermostat for Comfort and Savings. (1:56 min)



What type of air conditioning system do you have?

- ◯ Central air conditioning
- ◯ Window unit
- ◯ Split unit
- ◯ Portable unit

Let's find your thermostat. For central A/C, the thermostat is usually located on a wall in a central area of your house and can look many different ways.
Below are a few examples (though these aren't all the different types out there).

For all other types of cooling systems, the thermostat is usually in the unit.

Is your air conditioning / heating turned on today?

- ◯ Yes
- ◯ No

←

→

What is the setting of your thermostat in degrees Fahrenheit today? (only numbers please)

°F

What is the temperature outside today? (only numbers please)

Please take a photo of your current thermostat setting, and upload it below:
File format can be .jpg, .jpeg, or .png and no larger than 10Mb.

Please upload this picture even if the A/C unit is off today.

Drop files or click here to upload

Let's learn how to use our air conditioning system more efficiently and save energy throughout the year!

In California we have mild weather. However we can split the year into two different periods: a period of home heating (fall and winter), and a period of home cooling (spring and summer).

Heating Months (Fall and Winter):

- When you are home and awake, set your thermostat as low as is comfortable. 68°F is a good rule of thumb for California.

- When you are asleep or out of the house, turn your thermostat back 10° to 15° for eight hours and save around 10% a year on your heating and cooling bills. A smart or programmable thermostat can make it easy to set back your temperature.

- If you have a heat pump, maintain a moderate setting or use a programmable thermostat specially designed for use with heat pumps.

Cooling Months (Spring and Summer):

- Set your thermostat at a temperature you find comfortable and that provides humidity control, if needed. The smaller the difference between the indoor and outdoor temperatures, the lower your overall cooling bill will be. 78°F is a good rule of thumb for California.

- Allow your house to be warmer than normal when you are away, and lower the thermostat setting when you return home and need cooling. A programmable thermostat allows you to do this automatically and without sacrificing comfort.

- Avoid setting your thermostat to a colder setting than normal when you first turn on your air conditioner. It will not cool your home any faster and could result in excessive cooling and unnecessary expense.

Now go ahead and adjust your thermostat. The recommended settings for California are 78 degrees during the cooling months, and 68 degrees during the heating months.

What is the NEW setting of your thermostat in degrees Fahrenheit? (only numbers please)

°F

Please upload a photo of your thermostat after the activity has been completed.
File format can be .jpg, .jpeg, or .png and no larger than 100Mb.

Drop files or click here to upload

When using laundry machines, make sure to choose settings that use cold or warm water instead of hot water, especially if your clothes are lightly soiled and do not require sanitization. Picking such settings will still clean the clothes since most modern-day detergents easily dissolve in cold and warm water. It will also save energy! Using cold instead of hot temperature setting can save you around 760 Wh of energy, which is enough to power a household refrigerator for over 16 hours or a microwave oven for about 40 minutes.

Please take a photo of your washing machine setting next time you wash your laundry and upload it here.
File format can be .jpg, .jpeg, or .png and no larger than 100Mb.

Drop files or click here to upload

Fridge Dial

Now let's take a look at our refrigerators and learn how to maximize their energy efficiency.

We highly advise you to complete this part of the activity with another family member so they too can understand how exactly your household refrigerator operates and learn how to get the most out of your fridge to save energy and money!

Before we begin, let's first identify which image below most closely resembles your refrigerator.

It's completely okay if your fridge doesn't completely match the sample pictures, however, try your best to find a good match. For example, if your fridge utilizes numbers and a circular dial, refer to sample picture #1, whereas if your fridge has a digital interface that you can adjust but no notable units that you can reference like Fahrenheit or Celsius, refer to sample picture #7 or #8.

****If none of the sample pictures below are even remotely similar to your fridges thermostat, please refer to these **general rules of thumb**:*

1) Unless your fridge thermostat shows a digital interface with adjustable and notable Fahrenheit or Celsius units, a higher number generally indicates a colder temperature.
2) If your fridge thermostat comes in the form of a circular dial, rotating it counter-clockwise will increase the temperature making it warmer. Like-wise, rotating it clockwise will decrease the temperature making it colder.
3) If none of the fridge samples below are even remotely similar to your fridge, BUT your fridge thermostat has recommended or starred (*) a particular number, letter, or region go ahead and dial your fridge to that region. That is most likely the ideal temperature for your fridge.

○ **#1.) CIRCULAR DIAL WITH NUMBERS**

○ **#2.) CIRCULAR DIAL WITH NO NUMBERS**

○ **#3.) CIRCULAR DIALS WITH NUMBERS AND MINI PICTURES**

○ **#4.) SLIDING DIALS WITH NUMBERS**

○ **#5.) SLIDING DIALS WITH LETTERS AND NUMBERS**

○ **#6.) DIGITAL INTERFACE WITH NOTABLE FAHRENHEIT UNITS**

○ **#7.) DIGITAL INTERFACE WITH NO NOTABLE UNITS**

○ **#8.) DIGITAL INTERFACE WITH NO NUMBERS**

Follow these instructions to discover how to adjust your fridge to its ideal settings

#1) *CIRCULAR DIAL WITH NUMBERS*

If you have a circular dial adjust that goes up to 9, adjust your dial so that it lands on 5. If your circular dial goes up to 7, adjust your dial so that it lands on 4, and if it goes up to 5, adjust it so it lands on 3. If your dial has a particularly unique number, adjust it so that it lands on the median number. For example, if your circular dial goes up to 13, adjust it to 7.

Note: Rotating it counter-clockwise will increase the temperature making it warmer, and like-wise, rotating it clockwise will decrease the temperature making it colder so make sure you are rotating it accordingly.

Before you rotated the dial, what temperature was it originally set at? (write your answer in the form of a fraction, if your dial goes up to 9 and was originally at 6 then your answer is 6/9)

What is the new temperature setting? (use the same fraction format you used in the previous question)

Follow these instructions to discover how to adjust your fridge to its ideal settings:

#2) CIRCULAR DIAL WITH NO NUMBERS

If you have a circular dial with no numbers that you can reference, try and find the minimum and maximum of where your dial ends first. For example, rotate your dial counter-clockwise to locate where the minimum temperature is (this is as warm as your fridge will go), then rotate your dial clockwise to determine where the maximum temperature is (this is as cold as your fridge will go). Then, try to adjust your dial so that it lands right in the middle between minimum and maximum.

Note: If you are feeling confused, the left side is usually the warmer side and the right side is usually the colder side.

Before you rotated the dial, what temperature was it originally set at? (an approximation is okay)

- ◯ Warmest
- ◯ Warm
- ◯ Medium
- ◯ Cold
- ◯ Coldest

What is the new temperature setting AFTER you rotated the dial?

- ◯ Warmest
- ◯ Warm
- ◯ Medium
- ◯ Cold
- ◯ Coldest

Follow these instructions to discover how to adjust your fridge to its ideal settings:

#3) CIRCULAR DIALS WITH NUMBERS AND MINI PICTURES

If your circular dial has both numbers and mini-pictures and designs (such as a snowflake or igloo) try and count up how many pictures and numbers there are. Typically, the image is representative of a number/how cold or warm that temperature is. For instance, the image of the larger snowflake can just be translated to 6 (which is colder than 5), and the igloo can be translated to 7 (which is colder than 6). Since the maximum for this dial is 7, simply adjust your dial so that it lands on 4. If you finish counting up all the numbers and images and notice that the maximum is 9, adjust your dial so that it lands on 5.

Note: If your dial has a particularly unique number, adjust it so that it lands on the median number. For example, if your circular dial goes up to 13, adjust it to 7.

Before you rotated the dial, what temperature was it originally set at? (write your answer in the form of a fraction, if your dial goes up to 9 and was originally at 6 then your answer is 6/9)

What is the new temperature setting? (use the same fraction format you used in the previous question)

Follow these instructions to discover how to adjust your fridge to its ideal settings:

#4) *SLIDING DIALS WITH NUMBERS*

If you have a sliding dial with numbers that goes up to 4, adjust your dial so that it lands on 2.5. If your sliding dial goes up to 7, adjust your dial so that it lands on 4, and if it goes up to 5, adjust it so it lands on 3. If your dial has a particularly unique number, adjust it so that it lands on the median number. For example, if your sliding dial goes up to 9, adjust it to 4.5.

Note: Sliding it to the left will increase the temperature making it warmer, and like-wise, sliding it to the right will decrease the temperature making it colder so make sure you are sliding it accordingly.

Before you rotated the dial, what temperature was it originally set at? (write your answer in the form of a fraction, if your dial goes up to 9 and was originally at 6 then your answer is 6/9)

What is the new temperature setting? (use the same fraction format you used in the previous question)

Follow these instructions to discover how to adjust your fridge to its ideal settings:

#5) SLIDING DIALS WITH LETTERS AND NUMBERS

If you have a sliding dial with both numbers and letters, try and find the maximum first. For example, if your thermostat goes up the letter E, that essentially just means it goes up to 5 (if you count A,B,C,D,E the total number of letters is 5). As such, simply slide your dial so that it goes to C (which translates to 3). If your thermostat goes up to G, simply slide it to D which is representative of 4. If your dial has a particularly unique letter, adjust it so that it lands on the median letter. For example, if your circular dial goes up to "I", adjust it to E.

Similarly, if you have a sliding dial with numbers that goes up to 4, adjust your dial so that it lands on 2.5. If your sliding dial goes up to 7, adjust your dial so that it lands on 4, and if it goes up to 5, adjust it so it lands on 3. If your dial has a particularly unique number, adjust it so that it lands on the median number. For example, if your sliding dial goes up to 9, adjust it to 4.5.
Note: Sliding it to the left will increase the temperature making it warmer, and like-wise, sliding it to the right will decrease the temperature making it colder so make sure you are sliding it accordingly.

Before you rotated the dial, what temperature was it originally set at? (write your answer in the form of a fraction, if your dial goes up to 9 and was originally at 6 then your answer is 6/9. Translate the letters to numbers to determine what your temperature was originally set at).

What is the new temperature setting? (use the same fraction format you used in the previous question)

Follow these instructions to discover how to adjust your fridge to its ideal settings:

#6) DIGITAL INTERFACE WITH NOTABLE FAHRENHEIT UNITS

If your fridge has a digital interface with Fahrenheit or Celsius units, simply adjust your temperature to 37 degrees Fahrenheit or 2.7 degrees Celsius. If possible, also adjust your freezer digital interface to 0 degrees Fahrenheit or -17.7 degrees Celsius.

Before you adjusted the setting, what temperature was it originally set at? (please use Fahrenheit)

What is the new temperature setting? (please use Fahrenheit)

Follow these instructions to discover how to adjust your fridge to its ideal settings:

#7) DIGITAL INTERFACE WITH NO NOTABLE UNITS

If your fridge has a digital interface with numbers and NO units, first determine what the maximum number. Then, touch the button to make sure that the number lands in the middle between minimum and maximum. For example, if the maximum number is 7, press the digital interface until the number reaches 4. If your fridge has a particularly unique maximum number, adjust it so that it lands on the median number. For example, if the maximum is 13, make sure the number lands on 7.

Note: The higher the number the colder the temperatures. Likewise, the lower the number the warmer the temperature.

Before you adjusted the dial, what temperature was it originally set at? (write your answer in the form of a fraction, if your dial goes up to 9 and was originally at 6 then your answer is 6/9. Translate the letters to numbers to determine what your temperature was originally set at)

What is the new temperature setting? (use the same fraction format you used in the previous question)

Follow these instructions to discover how to adjust your fridge to its ideal settings:

#8) DIGITAL INTERFACE WITH NO NUMBERS

If your fridge has a digital interface with NO numbers, count up how many circles/options it gives you. For instance, the example picture shows 4. After determining the maximum amount of circles, try and find the median circle. For example, if the maximum amount of circles is 7, press the digital interface until the number reaches 4. If your fridge has a particularly unique maximum number, adjust it so that it lands on the median number. For example, if the maximum is 13, make sure the number lands on 7.

Note: If you are feeling confused, the circle located on the very left usually indicates the warmest temperature, and the circle on the right usually indicates the coldest temperature.

Before you changed the settings what temperature was it originally set at? (write your answer in the form of a fraction, if you have 4 total buttons/options and your setting was originally at 2 then your answer is 2/4)

What is the new temperature setting? (use the same fraction format you used in the previous question)

Congratulations, you have now successfully maximized your fridge's energy settings!

Now, please upload a picture of your fridge thermostat with its ideal temperature!

File format can be .jpg, .jpeg, or .png and no larger than 10Mb.

Drop files or click here to upload

Thank you for completing this activity!

Your response has been recorded and you can now close this window.

- The Dial Down Challenge Team.

Week 2 – Energy in the Kitchen

Week 2 | Energy in the Kitchen

This week, we're taking a look at energy in the kitchen and finding out all the ways we can dial it down!
Follow this energy-saving checklist to find out all the simple, easy ways you can conserve energy as you go about your culinary creations.

We recommend challenging yourself by trying out a new sustainable vegan recipe (find some inspiration from this **list** --- feel free to mix things up with different ingredients and spices of your choice! We also encourage you to work with your family in walking through this checklist and crafting your delicious meals.

After whipping up your meal, make sure to snap a picture of your masterpiece and share it to our Instagram account **@dial_down_ or** to our Facebook page **Dial Down Challenge**... Don't forget to tag us #DialDown2021

Estimated time completion: 30-40 minutes.

PREPPING

How many times did you and your cooking partner open and close your fridge while gathering ingredients and prepping for your meal?

- ◯ Less than 2 times
- ◯ 3 times
- ◯ more than 4 times

FUN FACT:
Did you know that every time you open your fridge it has to compensate for the lost cool air by using up more energy? In fact, everytime your fridge door opens, half the cool air in your fridge is emptied out within 10 seconds

How many portions of ingredients are you working with? Are you just cooking dinner for you and your family, or also extra portions that you and your family can bring to lunch tomorrow?

- ◯ Just dinner for me
- ◯ Dinner for me and my family
- ◯ Dinner and lunch for me
- ◯ Dinner and lunch for both me and my family

FUN FACT: Did you know that cooking in bulk is one of the easiest ways to save energy in the kitchen as you don't have to cycle through all your appliances as well as the various processes of reheating over and over again.

Ask your family/cooking partner if they are interested in cooking in bulk to save time, energy, and money. What is their response?

- ◯ Our family already regularly cooks in bulk!
- ◯ No, we prefer to cook each individual meal
- ◯ No, we typically eat out/buy our meals instead of cook it
- ◯ Yes we would be interested in starting to cook bigger portions to save time, energy, and money in the future!

Are you washing all your ingredients one by one or in a partially-filled sink or basin?

- ◯ One by one under continuously running water
- ◯ All at once in a partially filled sink/basin

COOKING

How did you boil water while cooking your meal?

- ◯ I boiled it in a pan on my stove
- ◯ I boiled it in an electric kettle first and then transferred the boiled water into a pan
- ◯ I used the microwave

FUN FACT: The kettle is designed to bring water to a boil as quickly as possible allowing you to save as much energy as possible.

Are you covering all your pots and pans with their designated lids while cooking in order to prevent heat loss?

- ◯ No, I don't even know where all my lids are
- ◯ Yes, all of them are covered!

How often are you using your microwave to defrost/heat your ingredients in comparison to your oven?

- ◯ I only used my oven
- ◯ I used both my oven and my microwave
- ◯ I only used my microwave
- ◯ I defrost by leaving things outside of the fridge

FUN FACT: Did you know that microwaves are one of the most energy-efficient means of cooking, followed by slow cookers, stovetops, and lastly ovens?

dial down CHALLENGE

CLEANING

Which of your electrical appliances have you unplugged after you've finished cooking?

- [ ] Toaster
- [ ] Electric Kettle
- [ ] Microwave
- [ ] Coffee maker
- [ ] Toaster Oven
- [ ] Air fryer/slow cooker
- [ ] We do not use any electrical appliance in our kitchen
- [ ] We did not unplug any electrical appliances after we've finished cooking

FUN FACT: The best way to spot if something is using up energy is to see if there are any blinking lights or attached cords.

If you use a dishwasher, what do you usually do after your dishwasher finishes its cycle?

- ◯ I click the dry cycle function
- ◯ I open the dishwasher and let my plates, utensils, and bowls air dry
- ◯ I use a dishwasher, but it doesn't have air dry option
- ◯ I don't use a dishwasher

The **refrigerator** is one of the highest energy-using devices in any modern household because it operates 24 hours per day.

Every time you open your fridge for 10 seconds, your fridge has to use up an additional 7% of its energy to replace the cool air that is being lost which translates into a higher electricity bill, and an increased amount of energy being lost.

Ask your family/cooking partner if they've noticed that the fridge thermostat was altered and explain why you did so.

What was their response?

- ◯ They didn't notice it was changed
- ◯ They adjusted the fridge thermostat with you!
- ◯ They noticed and don't see any differences in terms of fridge performance
- ◯ They changed the fridge thermostat back to its original setting

Please upload a photo of the current setting of your fridge dial below:
File format can be .jpg, .jpeg, or .png and no larger than 10Mb.

Drop files or click here to upload

Submit a picture of your culinary masterpiece!

File format can be .jpg, .jpeg, or .png and no larger than 10Mb.

Drop files or click here to upload

Thank you for completing this activity!

Your response has been recorded and you can now close this window.

- The Dial Down Challenge Team.

Week 3 – Shower better

Week 3 | Shower Better

Taking shorter showers is one of the best ways to save energy.

The average American showers for roughly 8 minutes using about 17 gallons of water each time. This accounts for 17 percent of the indoor water use at home.

But when you shower, you are not only using water, you are also using energy! According to the Environmental Protection Agency (EPA), the amount of energy it takes to treat and deliver water to just 10 houses in a year could power a refrigerator for six years!

Let's find out how many gallons of water you use when you shower!

For our calculations, we use the average shower flow rate of 2.1 gallons per minute. Although this number alone does not seem like a high value, you will soon see how quickly it adds up!

How long do you spend in the shower every time you shower? (enter only the number of minutes)

☐ minutes

How many times do you take a shower every week? (enter only the number)

☐

Your current water consumption in the shower is: 0 gallons per year.

Did you know?

A 15 minute shower uses the same amount of water as 2 full loads of laundry!

Let's see how your parent's water consumption compares to yours!

Try to time your parent or guardian the next time they shower. How long do they spend in the shower every time they shower? (enter only the number of minutes)

minutes

How many times does your parent or guardian take a shower every week? (enter only the number)

Your Parent's/Guardian's consumption in the shower is: 0 gallons per year.

... and your current water consumption in the shower is: 0 gallons per year.

Who has a higher water consumption? You or your parent/guardian?

- ◯ Me
- ◯ My parent/guardian
- ◯ It's the same

Now let's create a playlist of songs you can use to help reduce the amount of time spent showering.

Create a playlist that is about 5 minutes long and attach screenshot of it below.

See example below:

How long is your playlist? (enter the number of minutes)

_____ minutes

Please upload the photo of your playlist here:
Files can be .png, .jpg and no larger than 10Mb

Drop files or click here to upload

According to your playlist's duration, your new water consumption in the shower will be: 0 gallons per year.

If you commit to this change, you could be saving 0 gallons of water per year, also reducing the energy used to heat your water.

Now, share it with your friends and let them know how many gallons your playlist can save you!

Quick check to make sure you were paying attention!

What is the average shower flow rate?

- ◯ 10.2 gallons
- ◯ 5 gallons
- ◯ 2.1 gallons

How long should your shower playlist be?

- ◯ 15 mins
- ◯ 10 mins
- ◯ 5 mins

For a personal challenge, each time you shower try to beat your playlist. If you shower before your playlist stops you've won!

Next week we're going to be putting all of this knowledge to creative use! So start thinking about how you might want to convey the energy conservation information you've learned from these surveys in a digital, written, or artistic format!

Week 4 – Creative activity

dial down CHALLENGE

Week 4 Creative Activity

This week, create your own Dial Down inspired project. This is your chance to be creative and show what you have learned throughout the challenge. This can be accomplished in many different ways as long as you're being creative and including energy conservation themes. It could be a drawing/painting, photograph, poem, short story, short video or some other thing related to energy conservation.

If possible, please include your family members in your creative project. Examples of this could be giving them a small role in your video, an acknowledgement in your story, letting them help with your painting or anything else you can think of to get them involved!

Which theme from the challenge will be the inspiration for your creative project?

- ◯ Energy in the Entire Household
- ◯ Energy in the Kitchen
- ◯ Water usage
- ◯ Other

What form will your creative project take?

- ◯ Photograph
- ◯ Painting/Drawing
- ◯ Poem
- ◯ Short Video
- ◯ Short story
- ◯ Other

Were you able to get other family members involved?

- ◯ Yes
- ◯ No

How did you involve your family in your project?

- ◯ They are featured in the project
- ◯ They helped me with the project
- ◯ They are referenced in the project
- ◯ They were not involved
- ◯ Other

Can we display your project on our website (photo, painting, story, poem or video)?

- ◯ Yes
- ◯ No

Submission Instructions:

You must submit your project as either a link, jpg, or a pdf.

- Submit a jpg if you made a painting, drawing, or took a photograph. If it is a painting or drawing please take a photograph or scan your project to submit.
- Submit a pdf if you have written a poem or short story

If you are submitting your project as a link, please paste it here:

If you are submitting a jpg or pdf, please upload it here.
Files should not be larger than 10Mb.

Drop files or click here to upload

Did you complete this activity with your parents or legal guardians?

- ◯ Yes, we did it together
- ◯ No, I did it by myself

Thank you for completing this activity!

Your response has been recorded and you can now close this window.

- The Dial Down Challenge Team.

Week 5 – Recruitment activity

dial down CHALLENGE

Week 5 | Recruitment Activity

Congratulations! We made it to the final week!

This last activity is about getting people excited about the Dial Down Challenge. Follow the instructions provided in the email, and when you are ready, please complete this form.

Remember, the goal is to find three future energy stewards, but you can recruit as many people as possible. The more the merrier!

Please enter the emails of your recruits below. These future recruits can be friends, extended family members, neighbors, really anyone you'd like to share this important information with!

If your recruits are under 18 years old, please add their parents'/legal guardians' email too; otherwise, put "NA" for parent's/legal guardian's email.

	Future Energy Steward's email address	Their Parent's/Legal Guardian's email address
Future Energy Steward #1		
Future Energy Steward #2		
Future Energy Steward #3		
Future Energy Steward #4 (optional)		
Future Energy Steward #5 (optional)		

Did you complete this activity with your parents or legal guardians?

- ◯ Yes, we did it together
- ◯ No, I did it by myself

Thank you for completing this activity!

Your response has been recorded and you can now close this window.

- The Dial Down Challenge Team.

11. APPENDIX D

Certificate of Completion:

12. APPENDIX E

Table E1
Sociodemographic characteristics of participants

	Control group	Treatment group
	N=6	*N=12*
Gender	50% female	50% female
Educational attainment	100% of sample have college degree or higher	92% of sample have college degree or higher
Housing tenure	83% of sample own home	58% of sample own home
Race	67% of sample are Caucasian	75% of sample are Caucasian
Annual Income Range	$200,000 and above	$100,000 and above
Political leaning	67% strongly prefer Democrat	67% strongly prefer Democrat
Environmental organization	50% of sample are members of environmental organization	8% of sample are members of environmental organization

Note: We present here the sociodemographic characteristics of those participants who completed this section of the survey. Not all participants answered the socio-demographic questions, so this table does not represent the complete group of participants.

13. APPENDIX F

Table F1

Average number of checklist activities by group

	Week 1	Week 2	Week 3	Week 4	Week 5
	Mean (s.d.)	Mean (s.d.)	Mean (s.d.)	Mean (s.d.)	Mean (s.d.)
	Base *N* = 15	Base *N* = 15	Base *N* = 15	Base *N* = 15	Base *N* = 15
All teenagers	8.8	9.8	10.6	11.9	10.8
	(4)	(3)	(3.8)	(3)	(4.8)
Elementary school teenagers	7.8	8	10	11.5	10
	(3.8)	(1.4)	(4)	(3.5)	(5.5)
Middle school teenagers	12	12.3	13	13	13
	(3)	(3)	N/A	(1.4)	N/A
All parents	9	9	10.1	10.4	10.9
	(2.5)	(2.7)	(1.7)	(1.8)	(1.2)
Treatment group, parents	9	8.5	9.5	10.7	10.8
	(2.6)	(3.5)	(2.2)	(2.1)	(1)
Control group, parents	9.1	9.5	10.6	10	11
	(2.4)	(1.4)	(1.1)	(1.3)	(1.6)

Figure F1

Average number of activities per week reported by teenagers

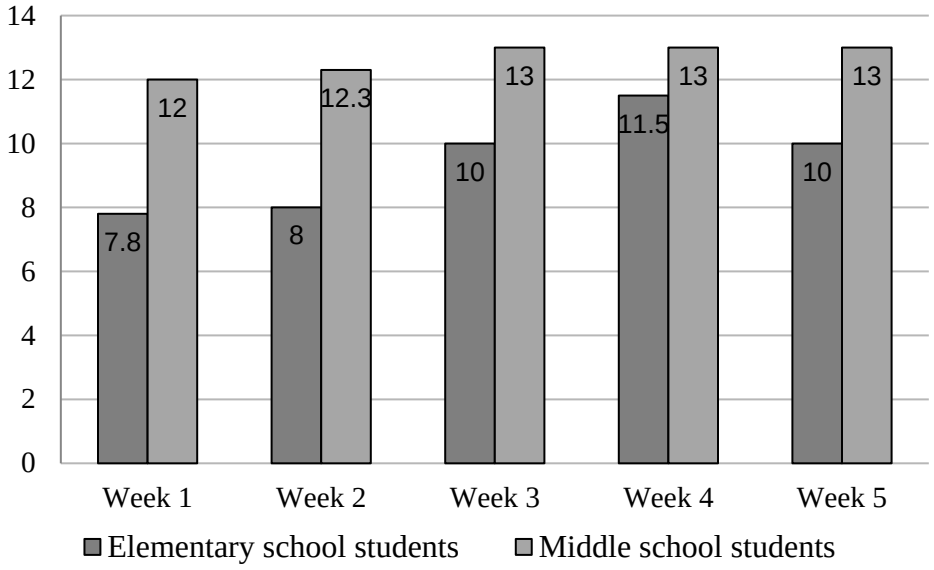


Figure F2

Average number of activities per week reported by parents

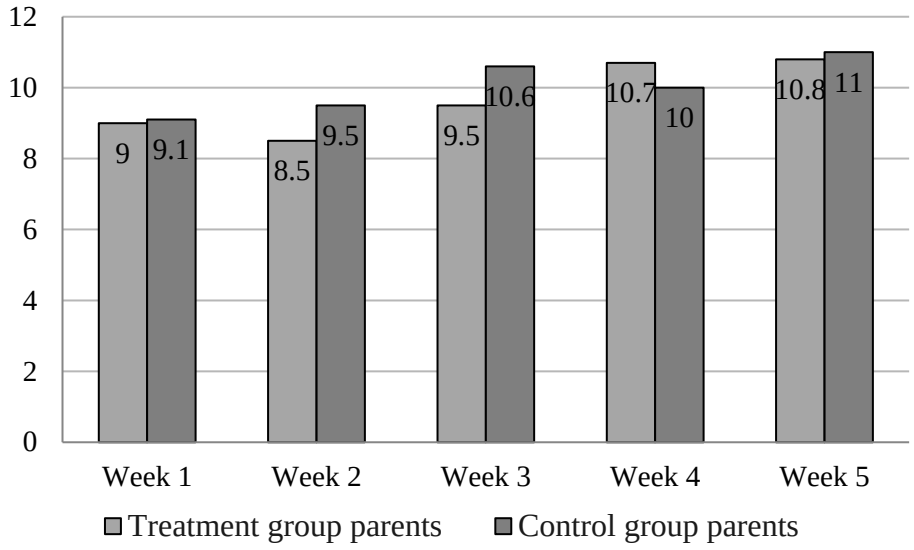


Table F2

Teenagers' responses to knowledge questions

Question	Student 1		Student 2		Student 3	
What percentage of your electricity usage do you estimate coming from:	Pre-survey	Post-survey	Pre-survey	Post-survey	Pre-survey	Post-survey
Overhead lighting	30	10	26	15	15	15
Space heating and cooling	10	10	30	34	15	15
Appliances plugged into electric outlets	30	40	15	10	25	30
Water heating	10	20	15	25	30	30
Refrigerator	20	20	14	16	15	10
If you set back your temperature 7-10 degrees Fahrenheit for 8 hours a day during a month, how much does it lower your heating costs? (estimate percentage of monthly cost)	40	20	15	28	5	7
What is the recommended setting for your air conditioning thermostat in the summer months in California if you want to be comfortable but save energy too?	1 (65 F)	2 (66F)	4 (68 F)	3 (67 F)	70F	6 (70 F)
On average, how many gallons of water can you save by reducing the time you shower from 10 minutes to 5 minutes	7 (from 18-20 gallons)	18-20 gallons	2 (3-5 gallons)	6-8 gallons	3-5 gallons	18-20 gallons
T/F: The refrigerator temperature for optimal energy performance is about 36.5 F	T	T	T	T	F	F
T/F: Refrigerators run more efficiently when they're almost empty	F	F	F	T	T	T
T/F: A fridge in a warm garage (about 90F) will consume up to 50% more energy than one placed inside a cooler indoor area	T	T	F	F	T	T
T/F: It's OK to open the fridge many times, as long as you do it quickly	F	F	F	F	F	F

N = 3

Note: Amongst all participants, only three teenagers completed the pre- and post-survey

Table F3

Parents' responses for energy conservation awareness, before and after the experiment

	Pre-survey Mean (s.d.) Base	Post-survey Mean (s.d.) Base
Rate the following statements from strongly disagree (1) to strongly agree (5)	$N = 9$	$N = 9$
Reducing electricity consumption at home is an important thing to do	4.3 (1)	4.8 (0.4)
Reducing electricity consumption at home will be valuable to me	4.4 (0.7)	4.7 (0.5)
Reducing electricity consumption at home is pointless, a waste of my effort	1 (0)	1.1 (0.4)
I cannot see the use of reducing electricity consumption	1 (0)	1.4 (0.5)
Learning to reduce electricity consumption is useful to me	4.7 (0.5)	4.9 (0.4)
I know how to achieve the maximum reduction in electricity	2.7	4.6
People in my community are energy-conscious	3.1 (1.5)	3.6 (0.9)
My community expects me to conserve energy	3.7 (1.2)	3.3 (1.2)

Table F4

Average change in parents' concern responses

Concern: Rate the following statements from strongly disagree (1) to strongly agree (5)	Average increase in response
Reducing electricity consumption at home is an important thing to do	0.4
Reducing electricity consumption at home will be valuable to me	0.2
Reducing electricity consumption at home is pointless, a waste of my effort*	0.1
I cannot see the use of reducing electricity consumption*	0.4
Learning to reduce electricity consumption is useful to me	0.1
I know how to achieve the maximum reduction in electricity consumption at home	1.9
People in my community are energy-conscious	0.4
My community expects me to conserve energy	-0.3

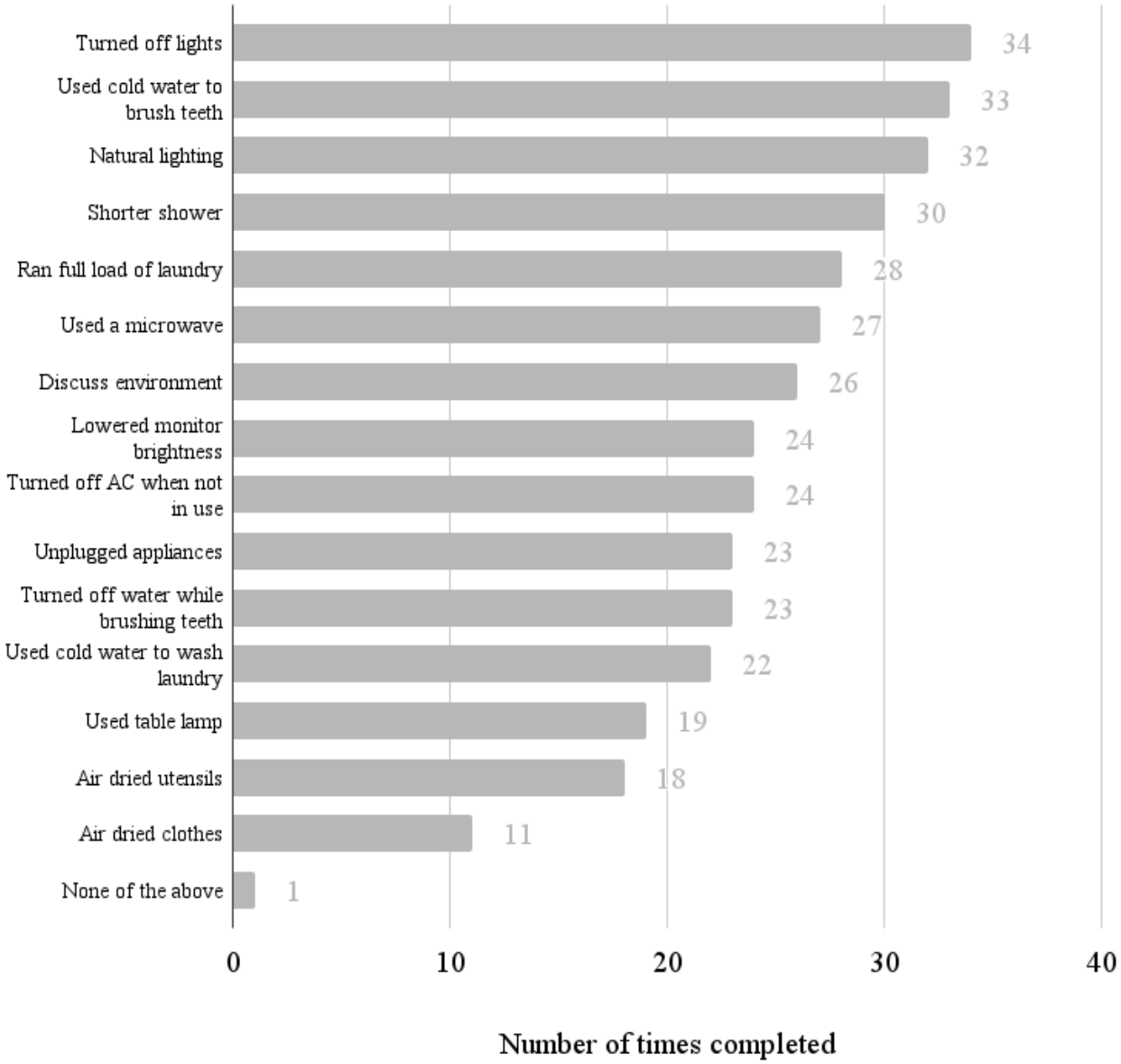
$N = 8$

Note: Questions marked with an asterisk (*) are reverse coded from strongly agree (1) to strongly disagree (5).

14. APPENDIX G

Figure G1

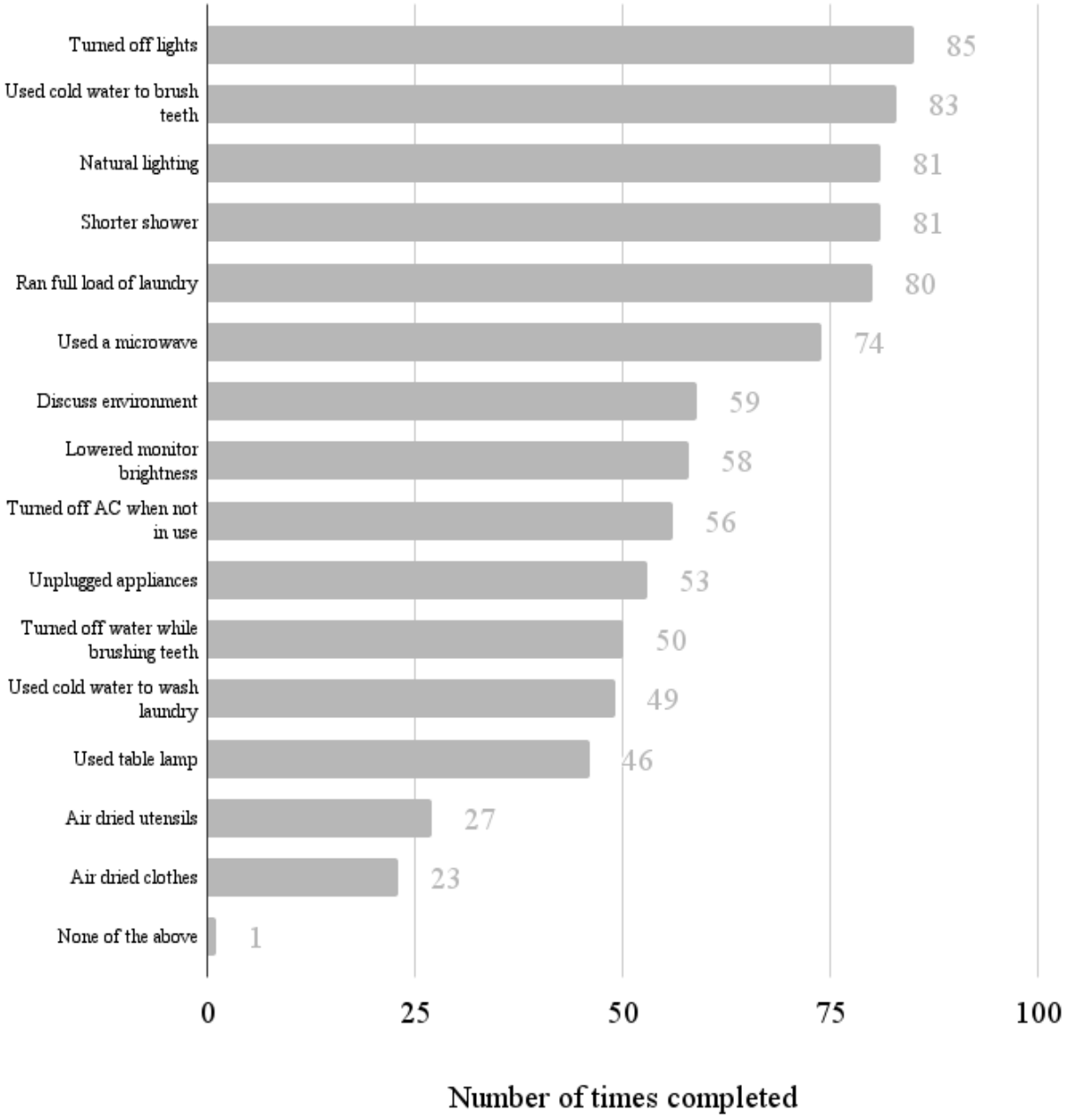
Activities completed by all teenagers, all weeks



Note: The total number of participants is 14. Due to attrition, the maximum possible number of times an activity could be completed over the entire five weeks is 40.

Figure G2

Activities completed by parents, all weeks



Note: Total number of participants is 58. Due to attrition, the maximum possible number of times an activity could be completed over the entire five weeks is 92.

Figure G3

Activities completed by parents: baseline and final

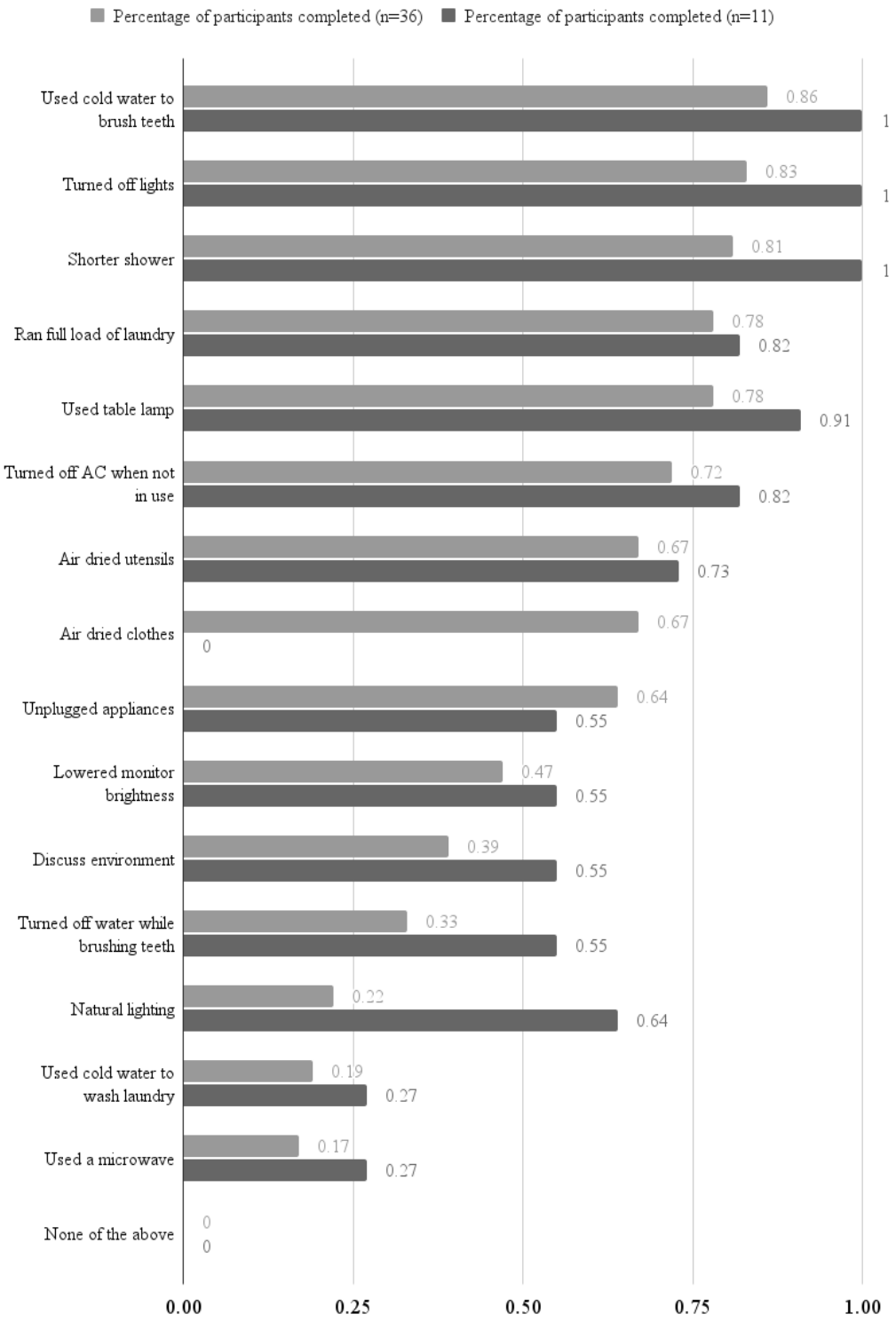


Table G1

Correlation between weekly family conversations about the environment and number of weekly checklist activities completed by parents

WEEK	CORRELATION
1	-0.29
2	0.16
3	0.14
4	-0.03
5	0.09

Note: Sample size is 58 parents.

Figure G4

Correlation between weekly family conversations about the environment and number of weekly checklist activities completed by parents, all weeks