Green Computing: Influencing Energy-Conserving Behaviour among Students on a University Campus

Research Project
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DALHOUSIE UNIVERISTY

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Executive Summary

This research project investigates student behaviour around computers on campus, with a focus on what motivates students to turn off their computers after use. The project entailed two distinct segments: an online survey open to all Dalhousie students, and an observational study which took place over two weeks in a biology computer lab and a lab in the Computer Science Building. The literature review influenced our project goals and methodology, which were designed to fill gaps in the existing literature regarding computer usage.

The online survey received a total of 151 responses from eligible Dalhousie students. Some notable results from the survey are that approximately three quarters of respondents simply click “log off” when they are finished using campus computers, 74% of respondents do not recall seeing any signs instructing them to turn off their computers, and the majority of respondents consider reducing their daily electricity consumption to be at least somewhat important.

The study in the computer labs involved four separate treatments in each of the two labs. Team members entered the labs to set up the initial conditions before the class arrived, and then returned to count the number of computers left on once all students had vacated. With these treatments we tested the effectiveness of signs and initial computer state (on or off) to determine what would influence students to turn off their computers after use. Results show that students in the computer science lab were much more responsive to the treatments than students in the ecology lab.

A major limitation in this project was the restricted time frame. In order to ensure the reliability of our results more replicates of each of the treatments are necessary. Despite our limited sample size, combining both the survey and study results allows us to provide some conclusive recommendations. Based on our findings, we recommend that there be more widespread use of “log off AND shut down (or sleep) options” without an option to simply log off and leave the computer on. Secondly, we recommend the use of signs across campus computer areas as our survey indicates that not many students have seen signage around campus. These signs should be designed to try to engage a behavioural response. Students are likely to turn off computers if they know how to and are reminded of need to reduce electricity consumption. We recommend that longer-term studies be conducted in university computer labs to investigate the replicability of our findings. We hope our findings will be used to help foster a distinct change in computer-use habits amongst students over time.

1 Introduction

1.1 Background and Rationale

Technology is rapidly developing and becoming more ubiquitous than ever before, especially personal computers which have advanced significantly over the past decade. As internet access becomes increasingly common, education has become significantly computerized (Altan, 2010). Regular access to computers is now a necessity at post-secondary institutions, as most course material is online. Students' courses at Dalhousie University in Halifax, Nova Scotia, for example, are managed online. Due to the large quantity of energy that computers use, discussions of how to reduce computers' electricity consumption and the corresponding emissions from this electricity generation must continue. With rising electrical costs and climate change posing an ever-greater threat today and for future generations, countries, corporations, and institutions worldwide are scrambling to find ways to reduce greenhouse gas (GHG) emissions. Reducing electricity consumption and improving efficiency are key goals in attempts to reduce GHG emissions (Harris et al., 2008), and there is potential to help slow the effect of climate change through the reduction of computer energy consumption (Kawamoto, 2004).

Reducing electricity consumption is a common goal for those interested in reducing indirect emissions, and Dalhousie has made clear attempts to conserve energy use across campus (Dalhousie Office of Sustainability, 2009). Dalhousie has signed the University and College's Climate Statement for Canada, setting a target of 50% CO_2 reductions by 2050 (Dalhousie Office of Sustainability, 2013). To this end, the University has committed to reduce their carbon footprint and become more efficient in their electricity use. Recently, the school has gone to some lengths to improve their monitoring capacity, for instance, by installing energy meters into various buildings and replacing old appliances with more efficient Energy Star appliances (Dalhousie Office of Sustainability, 2014). While it is commendable that the school's Office of Sustainability appears to be working towards extensive audits, methods to reduce electricity use thus far have focused on technical changes to equipment, or improving quantitative monitoring methods. There is an urgent need for behavioural studies of energy users. Therefore, we focused our study on energy-conserving behaviour amongst the increasing number of student computer users at Dalhousie.

In addition to being an area that Dalhousie has not strongly implemented thus far, several studies support the notion that behavioural change is the most effective method to reduce energy consumption in the long term. A student project from a previous year studied the energy use of computer labs at the University of King's College (Bishop, Fallis, Gleason, Maguire, & Vass, 2013). This study recommended that behaviour and attitudes of energy consumption be assessed among professors and students and whether a computer's start up time from being "off" is a legitimate barrier to turning computers off. This helped provide us with a quantitative background from which we narrowed our focus to study the behaviour of computer users. A complementary study by De Young explored behaviour-changing techniques as an alternative to traditional technical solutions (1997). Some behaviour-changing tools included the use of prompts, the establishment of community social norms, and verbal communication to create the desired behaviour (De Young, 1997). Based on the study of an Energy Culture framework

by Stephenson et al. (2010), influencing the initial power state of the computers is altering energy practice, and by extension, cognitive norms after repeated exposure of individuals and groups using computers on campus. The Energy Culture framework is a holistic approach to changing energy-consuming behaviour, by considering individual cognitive change and how a supportive environment can foster the development of the desired behaviour (Stephenson et al., 2010). Our team found the Energy Culture framework to be the most promising in bringing about computer energy consumption behaviour changes, and thus decided to test for multiple variables in our observational research component.

These studies suggest that the use of prompts and the establishment of social norms may create community-based behavioural changes. Due to time constraints, we are unable to implement or study a permanent shift in user culture and social norms regarding computer use. Therefore, we are focusing on the use of prompts (signage) and the influence of an "off" initial computer power state to bring about behavioural changes.

Eppel et al. (2013) discuss a food waste study called "The Food Loop" that took place within a community in England. The intention of the project was to engage individuals to want to participate, and make the benefits of the Food Loop apparent to them. Researchers found that members acted within seven distinct levels of support, which they classified as "positive greens, waste watchers, concerned consumers, sideline supporters, cautious participants, stalled starters, and honestly disengaged" (Eppel et al., 2013). These findings demonstrate that a variety of reactions are possible with a project that is aimed to change behavioural habits and improve sustainability overall. Therefore, we chose to examine trends related to a student's specific faculty association to determine whether students without formal education in sustainability are categorized in different levels of support than those students who have studied topics in sustainability.

1.2 Project Definition

Stephenson et al. (2010) used systems-based approaches to explain energy behaviours and found that changing norms, no matter how small the act, is an important step for changing energy consumption and habits of society in general. This suggests that encouraging students to save energy by turning off their computers after use may affect more general social change. Within the broader question of how students perceive the relationship between computer use and energy consumption, we were interested in what barriers students might perceive for reducing their power use, how important they see the issue of energy consumption, and if there were trends within and between different faculties. As a research tool, surveys are ideal for gaining large amounts of relatively non-specific information (Kirby, Greaves, & Reid, 2010) which was ideal for exploring these questions, and was chosen to attain various information about student's relationships with and perception of computers and energy issues. The relatively large sample size that a survey allows for enabled us to make stronger conclusions about students' perceptions of energy consumption, the influence faculty associations have on that perception, and the general barriers students perceive for reducing their power use.

Based on the existing research of computer energy consumption, we decided to assess the effectiveness of instructional signs, which have been shown to have a positive influence on behaviours (De Young, 1997). Secondly, we decided to investigate the role of the initial computer state in creating

an accepted norm for campus computer users. The initial power state of computers contributes to creating social and cognitive norms surrounding energy behaviours, and may have an influence on whether or not students turn their computers off (Stephenson et al, 2010). We chose to perform an observation test on students' behaviours, during which no direct observation occurred. This allowed us to develop an understanding of what measures may be taken on campus to encourage students to reduce their energy consumption. Furthermore, it was important to determine students' willingness to adopt the behaviour of energy consumption, and assess whether there are any barriers preventing students from doing so.

We aimed to answer the following questions:

1. What factors influence energy-saving behaviour amongst Dalhousie students using school computers?
2. How does the presence of signage and general culture of awareness affect energy saving behaviour?
3. Are there correlations between students from particular faculties and energy saving behaviour?

Based on our findings in the literature, we hypothesized that the presence of signage and initial "off" computer state will positively influence energy saving behaviour amongst students. The overall goal of this project was to determine how to cause a reduction in energy consumption on campus by influencing students' behaviours. Our goal in influencing behaviour was therefore to encourage students to turn their computers off after use. We did not quantify the amount of power we hoped to reduce, but rather focused on the goal of simply consuming less power than is used now.

This report will include detailed research methods for each of the lab observation and survey components, quantitative and qualitative results, interpretation of these results in the discussion, and our recommendations based on our findings for action and further research.

2 Methods

To examine student perception of computer power use we designed a short survey. In order to examine students' actual habits, we performed a behavioural study that examined students' responses to environmental prompts asking them to turn off their computers.

2.1 Survey

The survey was created using the online platform Google Drive in order to make survey response easy and accessible for respondents. This platform also made the data analysis process straightforward, and allowed us to ask a variety of question types. We ran a pilot test of our survey in order to determine that our questions were effective in gathering the information we needed, and that there were no technical problems with the survey. Once it was complete we administered it in two ways. A link to the survey was distributed online through facebook (a social media site). This distribution method was a form of haphazard sampling, and only those in the online social circles of the group members were exposed to it. We omitted the responses of individuals unaffiliated with Dalhousie or who do not use campus computers. The second way we administered the survey was a purposive non-probabilistic method, where we directly targeted students using computers. We printed links to the survey and attached them to chocolates as incentives. It is important to note we distributed chocolates as it may have influenced survey respondents and responses. These were then distributed to students working in the Killam Learning Commons. This allowed us to directly target students utilizing campus computers, without reference to factors such as faculty association or year of study. 230 chocolates were distributed from March 21st to 30th, 2014. We distributed chocolates evenly throughout the course of this time, so that our sample was not restricted to students who used the computers on specific days.

We used a variety of question types in the survey. All questions but the last were close-ended questions. Students were asked to identify their faculty association(s) and year of study. The remainder of the survey involved multiple choice questions examining the frequency respondents used computers, what current behaviours are, and what students may perceive as barriers to reducing consumption. We included options to indicate barriers that our research team see as preventing students from turning their computers off after use, but left an open ended question at the end asking respondents to identify barriers they perceive that were not included in the survey question. Senbel et al. (2014) explored energy conservation through peer engagement among university students found that one of the most important motivators for participation in the study was "concern for the environment/ global warming". We therefore included the question, "How important is it to you to minimize your daily electricity use?" in the online survey.

2.2 Behavioural Study

To complement the results of the survey, we chose to examine the effectiveness of two behavioural prompts in encouraging students to turn their computers off: the presence of a sign and the initial power state of the computer. Having all computers being off initially means that the norm is to have computers off when not in use, and vice versa. We examined the effects of these two variables alone and together, as outlined in Table 2.1. We based our experiment on the Stephenson et al. (2010) Energy Cultures framework, which suggests that environmental factors and social norms influence energy

saving behaviours. The presence of a sign that reminds the user of the electricity used to power their computer was intended to make students pause during this normal, everyday task. When leaving a computer room, the user must make a decision about whether to log off, log off and put the computer to sleep, or log off and shut the computer off. Because an action is required, this is an opportunity for the user to connect to the ecological consequences of their action before proceeding. This fits well within Eppel et al.'s discussion on breaking everyday habits in order to enact sustainable behaviour (Eppel et al. 2013). Although we could not heavily influence social norm due to time and scope constraints, it was plausible that the use of signage would create behavioural change amongst some students.

We studied two classes from different faculties, each with various lab sections. We used a purposive non-probabilistic form of sampling, targeting students in classes that use the labs on a weekly basis. Focusing on classes that used the computers at a designated time allowed us to more effectively monitor the results of each treatment, and allowed us to remove ourselves from direct observation of the students being studied. We chose to perform the study on a second year ecology lab as well as a first year computer science lab in order to explore the effects of prompts on students from different faculties and study the effects of differing fields of study. Performing the test on two classes also allowed us to increase our sample size within the time constraints.

Students were not directly observed due to ethical considerations, and because of the instructor's level of comfort in allowing their students to be studied without their students' consent. Since our experiment involved no direct observation, our methods were a form of trace analysis (Kirby, Greaves, & Reid, 2010).

We arrived at each lab early in order to set up treatments before any students in the ecology or computer science classes arrived. Prior to student arrival, each lab was set up in accordance to the treatment being tested (figure) for treatments 1 and 3, we placed eight signs (figure) throughout the lab. Signs were placed at roughly eye level on multiple walls throughout each lab to maximize visibility. For treatments 2 and 4 we ensured that there were no signs related to computer power use present in the lab. Following the setup of each treatment, we vacated the premises, and results were collected after all students left the lab. We asked the instructors of each lab to provide a head-count of students present during the session so that we could account for computers which were not used during the period.

Table 2.1 Description of treatment variables.

Treatment	Initial Computer State	Sign
1	On	Yes
2	On	No
3	Off	Yes
4	Off	No

We recorded the power state of computers as being “on” regardless of whether or not the computer monitor was off due to power saving settings which automatically shut off the monitor, but not the CPU.

2.3 Limitations of Methods

Time was the most significant limitation in administering our survey and performing the behavioural study. We were able to conduct behavioural studies from March 15th, 2014, when we received ethics approval, to the end of classes, only three weeks later. Because of this constraint, we were only able to perform each treatment once for each class we examined in the behavioural study. Given limited time and financial resources, we were only able to distribute a limited number of survey links, significantly limiting the number of responses received.

Contrary to the study design’s expectation, the computer labs under study were often open to the general student body prior to and following the scheduled lab times. Students unaffiliated with the lab were occasionally using computers while we set up or recorded data, a detail which was recorded and considered in the final results.

2.4 Delimitations to Methods

We were able to delimit the sample from which we drew our data. Our distribution of the survey, the focus of our behavioural study, and the phasing out of non-student respondents in the survey focused our research only on Dalhousie students who use campus computers. Our team also chose to examine two different aspects of student behaviour: the effects of signage and an initial “off” computer state. We designed our observational study to test the impacts of these two variables.

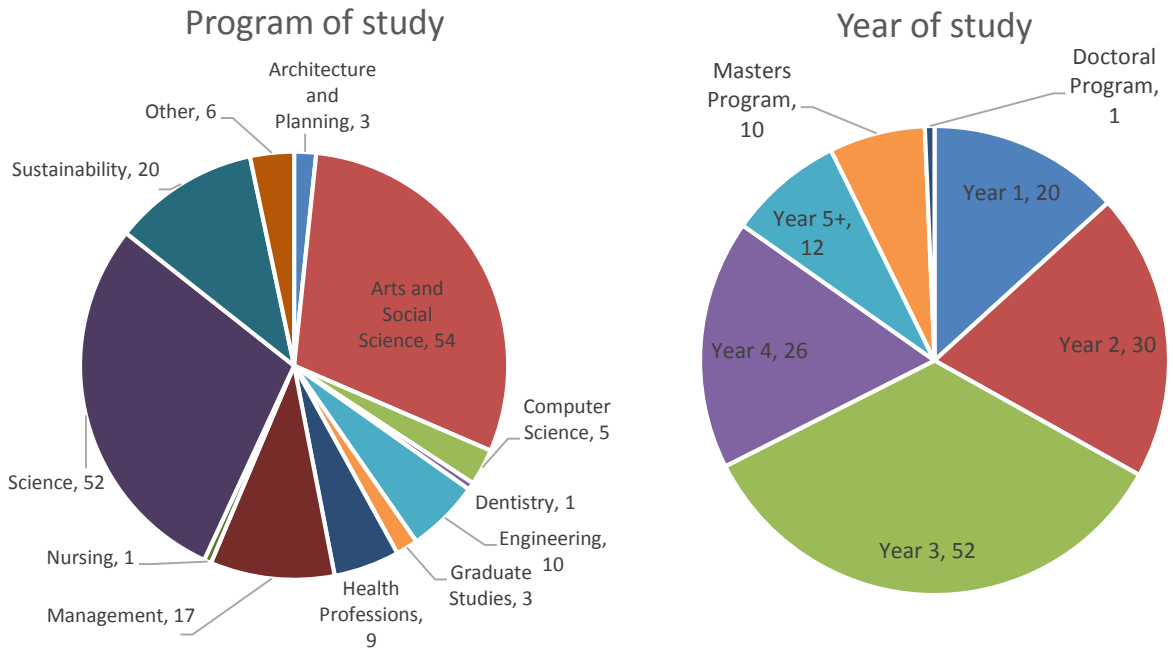
3 Results

The results from both the survey and behavioural study are discussed in this section.

3.1 Survey

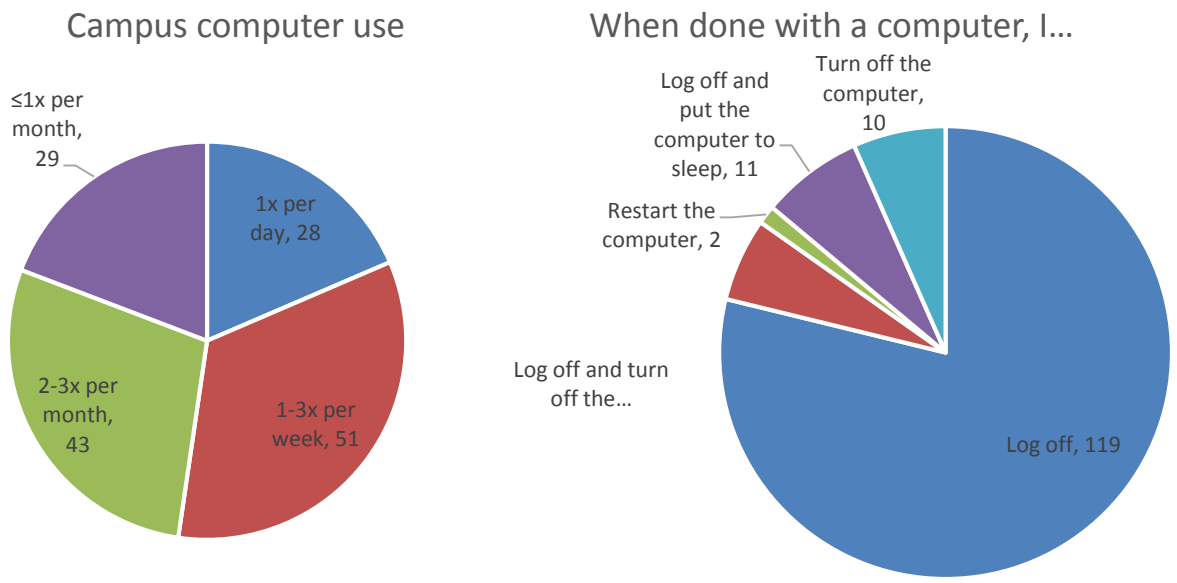
A total of 151 eligible Dalhousie University students from 12 areas of study responded to the online survey (Appendix A: Online Survey Questions). These individuals ranged from their first year of undergraduate study to the doctoral level (Figure 3.1).

Figure 3.1 Summary of respondents' program and year of study in a survey on campus computer use at Dalhousie University.



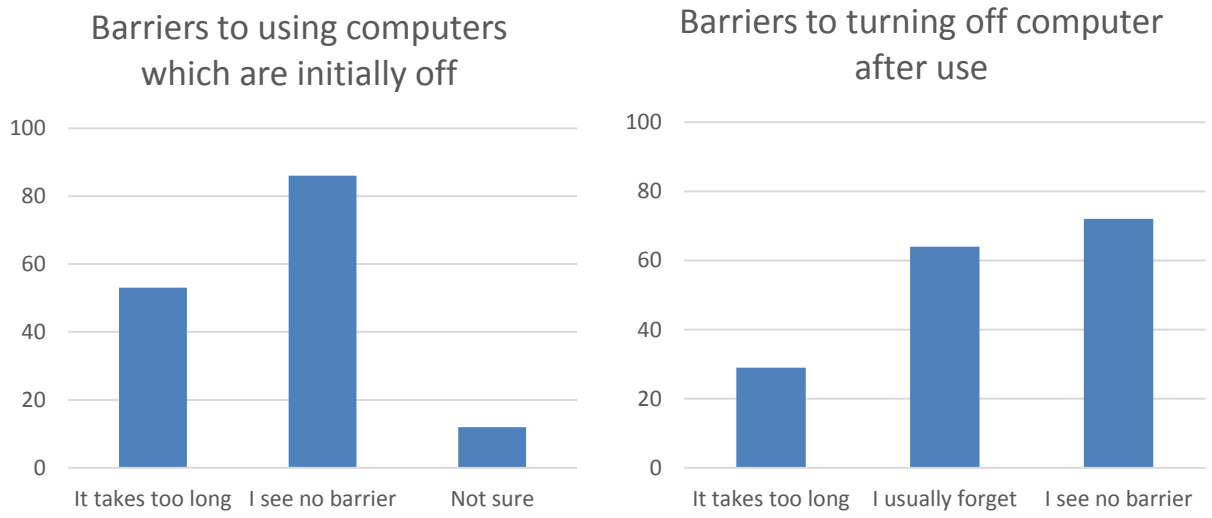
Respondents reported a wide range of usage patterns for campus computers, from once daily, to once or less per month (Figure 3.2). Respondents indicated that when they were finished using a campus computer 79% would log off, while 21% reported actions ranging from logging off and turning the monitor off, to shutting down the computer (Figure 3.2).

Figure 3.2 Summary of respondents' computer use and habits in a survey on campus computer use at Dalhousie University.



When asked about perceived barriers to using campus computers which are initially off, 57% of respondents reported that they saw no barrier to using these computers, while 35% said that waiting for a computer to boot up took too long (Figure 3.3). Those remaining reported that they weren't sure if they perceived a barrier. 44% of respondents indicated they saw no barrier to turning off campus computers when they were finished using them, while 39% reported that they usually forget. The remaining 17% reported that turning off the computer after use takes too much time.

Figure 3.3 Summary of respondents' perceptions of barriers in a survey on campus computer use at Dalhousie University.



Asked whether or not respondents had noticed signage asking computer users to turn off their computer after use, 13% responded yes, 13% responded they weren't sure, and the remainder responded no (Figure 3.4).

When asked about the personal importance of engaging in energy saving behaviour on a scale of 1-5, where 1 indicated the least importance and 5 indicated the most importance, the smallest proportion of respondents answered 1 or 2 (Figure 3.4). 28%, 33%, and 25% responded 3, 4, and 5, respectively, with an average response of 3.7. Evaluating the importance of energy saving by respondent's program of study shows that there is generally no significant difference between academic programs in the perceived interest of conserving energy (Figure 3.5). The only significant finding was that Architecture and Planning students generally rate energy saving behaviour as more important than management students.

Figure 3.4 Summary of respondents' observation of energy saving enforcing signage on campus, and the personal importance of saving energy in day-to-day life in a survey on campus computer use at Dalhousie University.

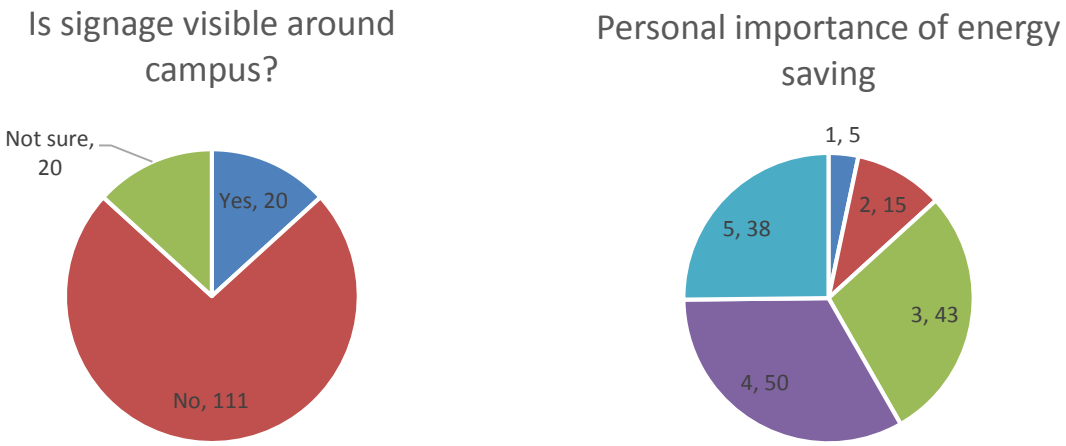
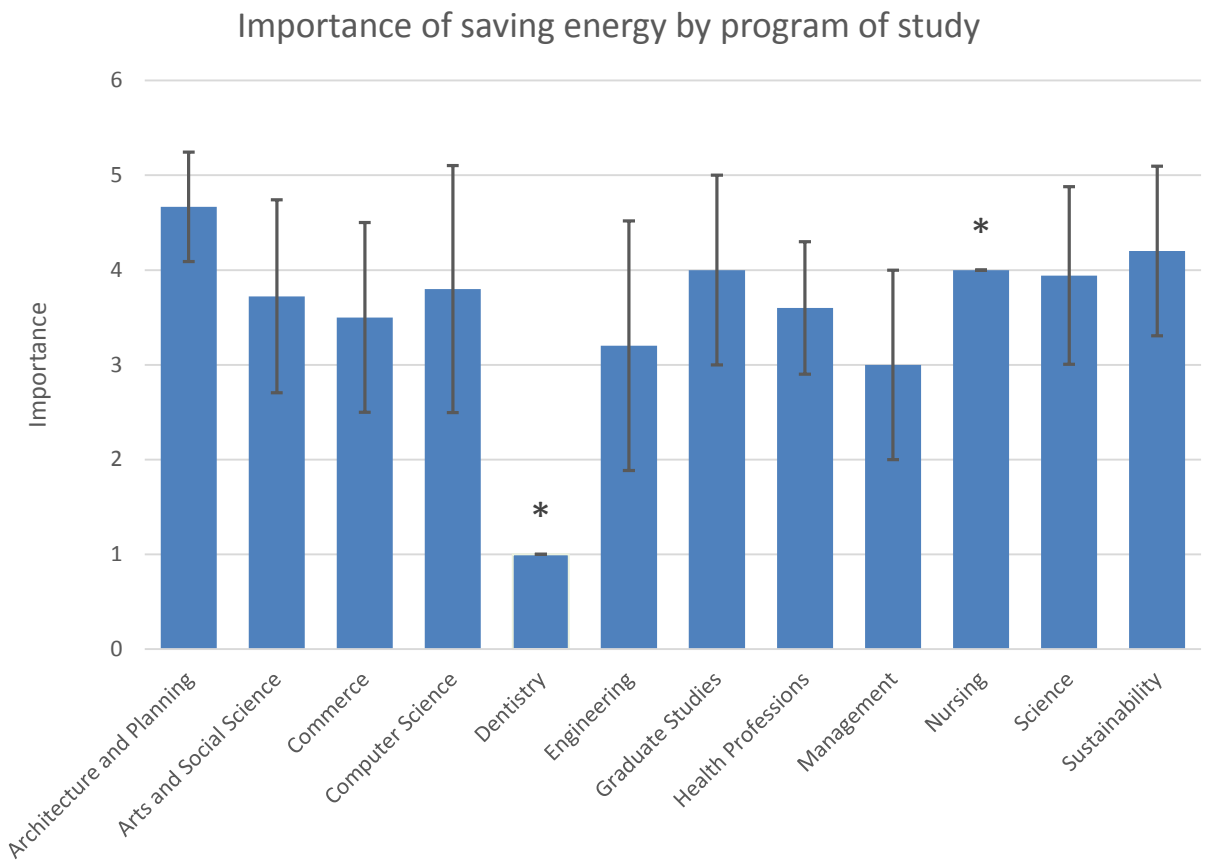


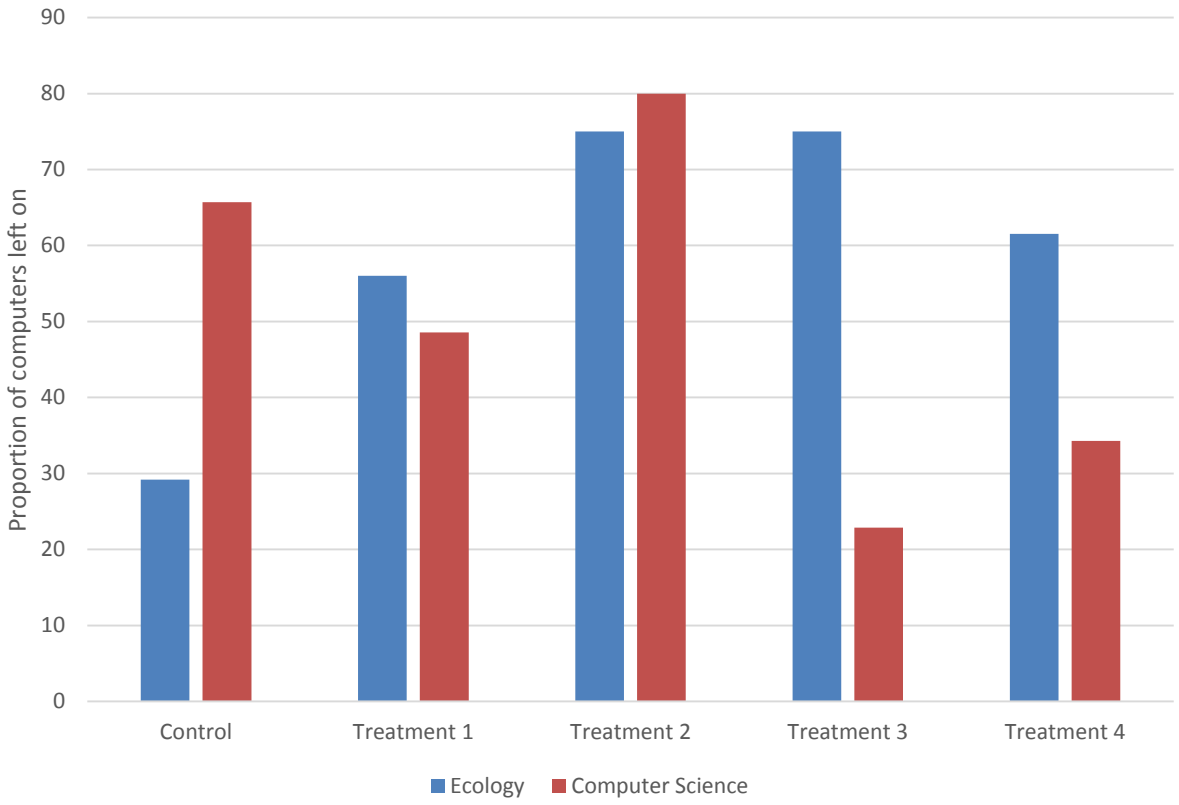
Figure 3.5 Summary of respondents' indication of the personal importance of saving energy in day-to-day life compared to their field of study in a survey on campus computer use at Dalhousie University. Non-significant results due to an insignificant number of responses are indicated by an asterisk.



3.2 Behavioural Study

Due to time limitations, only one replicate of each treatment could be conducted with each study population. Therefore, the results for this study (INSERT FIGURE) are not significant but indicate potential trends which should be investigated further. Students in the ecology lab left the smallest proportion of computers on after use in the control treatment (29.2%), and the largest proportion of computers on after use in both treatments 1 and 2 (75%). Students in the computer science lab left the smallest proportion of computers on after use in treatment 3 (22.9%), seemingly responding very positively to signage and computers which were found off upon arrival. Students in the computer science lab left the largest proportion of computers on after use in treatment 2 (80%).

Figure 3.6 Proportion of computers left on after use by two study populations using computer labs during class time: an ecology lab, and a computer science lab. Refer to Table 2.1 for treatment variables.



4 Discussion

4.1 Behavioural Study

The overall purpose of our research project was to determine whether student energy-saving computer behaviour could be influenced positively, and what the best ways to achieve this behaviour are. For the purpose of our research, we have defined "student energy-saving computer behaviour" as students choosing lower energy usage options when deciding what mode to put their computer in after use (i.e. choosing to turn "off" rather than leaving "on" would be considered an energy-saving computer behaviour).

We had findings that both supported and did not support our hypothesis. In our control results for both labs, we observed that ecology students had fewer computers left "on" after use, and computer science students had a higher number of computers left "on" after use (Figure 3.6). This indicates that perhaps ecology students are more educated and aware, based on their field of study, about the mitigation of negative impacts on the environment by reducing electricity use. Our findings may have value in influencing Dalhousie's curriculum because it indicates that education may be an effective means in influencing students to turn "off" their computer after use, or engage in other energy saving behaviours. It is important to mention that we are not aware of the pre-existing conditions when control results were collected (e.g. whether students were told to turn their computers off by their instructor).

Our research team predicted that the application of treatment 3 (refer to appendix X) would yield the lowest number of computers left on after use. This prediction was based on research indicating signage is an effective prompt (De Young, 1997), to remind students to turn off their computers. Furthermore, our literature review also revealed that people seem to take on actions they are exposed to, meaning that if students continually approach and use a computer that is "off", they are more likely to leave it in an "off" setting. We speculate this will cause a durable change in behaviour, i.e. a lasting change (De Young, 1997).

When we applied treatment 3 in the computer science lab, we found that our results supported our hypothesis that signage and an initial "off" computer state is the most effective in positively influencing computer energy saving behaviour amongst students (please refer to lab observation figure). Furthermore, treatment 4 had the second greatest number of computer science student's turn off their computer (Figure 3.6). Therefore, we conclude that an initial "off" computer state is especially influential in having computer science students turn off their computers after use, while the most preferable condition is to have both the presence of signs and an "off" initial computer state.

The ecology lab observations did not support the original hypothesis, and differed from the computer science lab observations. Referring to (Figure 3.6), applying treatment's 2 and 3 both resulted in only 25% of students who turned off their computer despite the expectation that these two treatments would have the greatest difference. There are various possible reasons for why we see this in our results. Firstly, we were only able to collect one observation set (i.e. one replication per treatment per lab) due to time constraints. This makes the collected data limited. We would have liked to have more data to validate the trends we have identified, because with more applications of each treatment

we may have observed different patterns. Secondly, we think that the group of ecology students we observed during treatment 3 were more desensitized to the presence of signs. We noticed that prior to our observational study in the ecology labs, there was already a sign instructing students to turn off their computers (albeit, a plain one) located at the front of the computer lab. There was not a sign in the computer science lab prior to the start of our study. According to De Young, signs have less durability than other means of influencing behaviour once the newness or shock factor of the sign has worn off (1997). This leads us to believe that prompts were less effective when students had prior exposure to signs, and more effective for computer science students as they had no prior exposure.

For the ecology students, our results show that the presence of signs was more effective in inducing computer energy saving behaviour (treatment 1) than an initial "off" computer state (treatment 4). Contrastingly, the computer science students had a lower percentage of computers left on under treatment 4 than as compared to treatment 1. We found it curious that these results do not match, but thought of possible explanations to explain these findings. The group of ecology students we observed in the application of treatment 1 may be more familiar with the importance and positive impacts that turning off their computer has in saving electricity, as was discussed earlier. Therefore, signs would be expected to be an effective behaviour inducer because ecology students simply need that reminder (prompt) to take action. It is important to note that our results from the application of treatment 1 in the ecology lab implies signs are more effective in inducing energy-saving computer behaviour than initial computer state, while results from treatment 3 in the ecology lab indicate that an initial "off" state is most effective in inducing energy-saving behaviour. We speculate these conflicting results are due to poor validity of the data because we only ran one observation per treatment.

Computer science students have perhaps not learned the positive impacts that turning off their computers after use has on saving computer electricity consumption. Thus, when they observe behaviours before they have the option to decide whether to leave on or shut down their computers, they are likely to tend towards adopting the same behaviour as was observed. This means that treatment 4 (no signs, with an "off" initial computer state) is more effective in teaching a behaviour to the students, than acting as a prompt for those who have already learned the behaviour.

4.2 Survey

The second data collection tool we used was an online survey. We had 151 eligible respondents participate in our survey, and our results helped us determine people's preferred behaviour with regards to computers and their attitudes toward reducing their energy consumption. We found that just over 75% of respondents simply "logged off" after they were done using their computer (Figure 3.2). Furthermore, nearly 75% of respondents indicated that they have not seen "turn off your computer" signs around campus (Figure 3.4). Our team drew a connection by comparing these two results: the lack of signage used on campus may be negatively influencing the number of people who shut down their computers after use.

Furthermore, we found that half of the survey respondents reported it is important to them to minimize their daily electricity use (ranking a 4 on a 1 to 5 scale; 1 being not at all important) (Figure 3.4). The two next most frequent responses were a 3 and 5, respectively. These results, coupled with the

majority of students indicating they do not see barriers to using computers that are turned off (Figure 3.3), lead us to believe that more signage around campus computer areas will serve as effective prompts in reminding students to turn off their computers since the majority of students do care about minimizing their electricity usage.

Lastly, the survey results indicate that Faculty of Architecture and Planning students rank the importance of reducing their daily electricity consumption as greater than Management students (Figure 3.5). This leads us to conclude that students in different faculties have varying perceptions of the importance of reducing their daily electricity use. With additional time, we would have liked to get a more representative sample of students from many faculties to draw statistically significant results.

4.3 Connection to Literature

Our findings have mixed results in supporting existing research studies. We were able to work with suggestions for further research from the King's Computer Lab Audit (Bishop, Fallis, Gleason, Maguire, & Vass, 2013) which indicated that research into barriers for turning off computers after use needed to be further explored. From our survey, as mentioned above, the majority of students saw no barriers. This is a valuable result as it suggests that computer settings with "log off and shut down" options would be accepted by most students and therefore would have a relatively smooth implementation and high acceptance. We did, however, have a comment left by a survey respondent indicating that they did not want to pose an inconvenience (by turning their computer off) to the next person to use the computer. Based on this concern, we suggest that further research includes interviews to further examine complex barriers. Coupled with the King's Computer Lab Audit research, we know that having computers in the "off" setting will conserve more electricity than alternative states (Bishop et al., 2013), and that we can influence this behaviour through limited options ("log off and shut down", with no availability to simply "log off") coupled with signs.

According to De Young's research, signs acting as prompts are effective ways in maintaining established norms (1997). We found this was the case with ecology students (i.e. students generally more familiar with the importance of turning off their computer after use) and not computer science students. Our research suggests that signs are effective in reinforcing behaviour, which is consistent with De Young's research (1997), but that an initial "off" computer state is more effective for teaching a behaviour and over time will help solidify behaviour. Combined, signs and initial "off" computer state are the most effective of the potential combinations when considering the two variables in creating a social environment with regard to computer energy saving behaviour.

5 Conclusions

5.1 Major Contributions of the Study

Computer use is becoming ubiquitous, especially amongst student populations who rely on access to computers (Altan, 2010). Since computing is a significant source of electricity consumption within universities, campus policies that improve efficiency and reduce consumption are key in decreasing GHG emissions (Harris et al., 2008). Dalhousie University and its Office of Sustainability have shown initiative to reducing electricity consumption on campus. The university has primarily made technological changes to reduce energy consumption on campus (Dalhousie Office of Sustainability, 2013). Evidence in the literature suggested that using techniques to change behaviour and establish social norms, such as emotionally-tied prompts, could be as effective in reducing energy consumption as technological solutions (De Young, 1997; Chiang et al, 2014). In order to address the urgent need for an alternative solution, our team investigated whether visual prompts and/or initial computer state influence energy-saving behaviour amongst Dalhousie computer users. Our findings allowed us to determine possible avenues to achieve a positive shift in energy consuming behaviour. We explored energy-saving behaviours in two distinct ways:

1. The observational study allowed us to gauge what measures should be taken to encourage energy reduction on campus by investigating students' responsiveness to prompts and initial power state of computers. Data from the control groups revealed that ecology students were more likely to turn computers off after use than computer science students. We can infer that students studying ecology are likely much more keenly aware of the environmental consequences related to everyday actions (including energy consumption) than their peers studying computer science. Analysis of treatment results, particularly treatment 3 in the computer science lab supported our hypothesis, but the ecology lab yielded different results. Our speculation that ecology students had become desensitized to the presence of signs is supported by De Young's (1997) study, which suggested that prompts were less effective when students had already been exposed to signs. Further conflicting results are due to poor validity of the data owed primarily to time constraints.
2. Our survey developed our understanding of students' perception of computer energy-consumption, barriers to turning off computers, and the presence of signage on campus. A majority of respondents reported that it is important to them to minimize their daily electricity use, that they perceived no barriers to using computers when they are "off"/turning "off" computers after use, and that 75% of participants were unaware of signage.

The findings both supported and rejected our hypothesis. Particularly, the results of treatment 3 on the CS students was especially supportive of our hypothesis. Separate research focuses complimented each other to explore the relationship between perceptions regarding power use and student behaviour. Overall, the results led us to the conclusion that signs are effective in reminding students to turn off their computers once the behaviour has already been learned, and that initial computer state manipulation is effective in teaching a behaviour to students.

5.2 Recommendations for Action

There are various implications of our research on Dalhousie policy. Firstly, key decision-makers within the IT department should be involved in every stage to facilitate the transitional stage to program computers in medium to low traffic areas to solely offer a "log -off and shut-down" option. This will prevent computer users from leaving their computers on, as many students currently only log off from their computers, as indicated in the survey responses.

Further findings from our survey indicate that a shortage of signage on campus may be negatively influencing the number of people who shut down their computers after use. Additionally, observational research findings promote the use of signage as an effective means to incorporate energy-conservation behaviours in students. Chiang et al. (2014) studied the impact of displaying campus residence energy consumption on students' energy conservation behaviours. In this study, the ways in which the information appeared on the monitors varied. All the monitors displayed the same information (energy audit of the campus building) but through different means (analogue display, meter display, and emoticon display). Interestingly, the emoticon display was the most effective in reducing energy consumption amongst building users (Chiang et al., 2014). This supports the idea that prompts linking human emotions and energy consumption behaviour are more effective than means not affecting emotions, and could be integrated into a signage plan for the campus. Dalhousie should incorporate the use of signage in all computer use areas on campus, and incorporate content that links human emotional ties and energy consumption behaviour. This will help foster an energy culture with individuals choosing to turn off their computers becoming the accepted norm.

This plan fits with recent recommendations of Dalhousie University's Office of Sustainability, who, in the 2013 Greenhouse Gas Inventory stated that "[t]he Office will concentrate on developing a program to engage employees and students to shave off energy and water costs through day to day behaviours" (Dalhousie Office of Sustainability, 2013).

5.3 Recommendations for Further Research

Our team recommends further research on behavioural changes concerning energy conservation and computer use. The results have indicated signage as an effective tool to reduce energy use in the long-term. Multiple variables (i.e. plain signs, use of electricity consumption statistics linking to emotions, imagery) should be tested to determine the most effective way to encourage energy-saving computer behaviour. Furthermore, testing the effectiveness of signage in creating social disincentives explained in De Young's (1997) study that communicates potential consequences of excessive electricity consumption to the environment (e.g. indirect subliminal messages that denote effects of electricity consumption) thus influencing computer users to turn off their computers. Lastly, research that provides insight about bridging the divide between faculties' attitudes towards energy consumption will initiate more conclusive measures that should be taken to broaden the notion of environmentally sustainable practices amongst all faculties within university community.

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7 Acknowledgements

The research team would like to recognize Dr. Van Wilgenburg and Teaching Assistant Sydney Toni for their guidance throughout the duration of the research project. We would also like to acknowledge the Biology and Computer Science professors and instructors who allowed our team to conduct the observational studies within their classrooms, and all participants for contributing to our online survey.

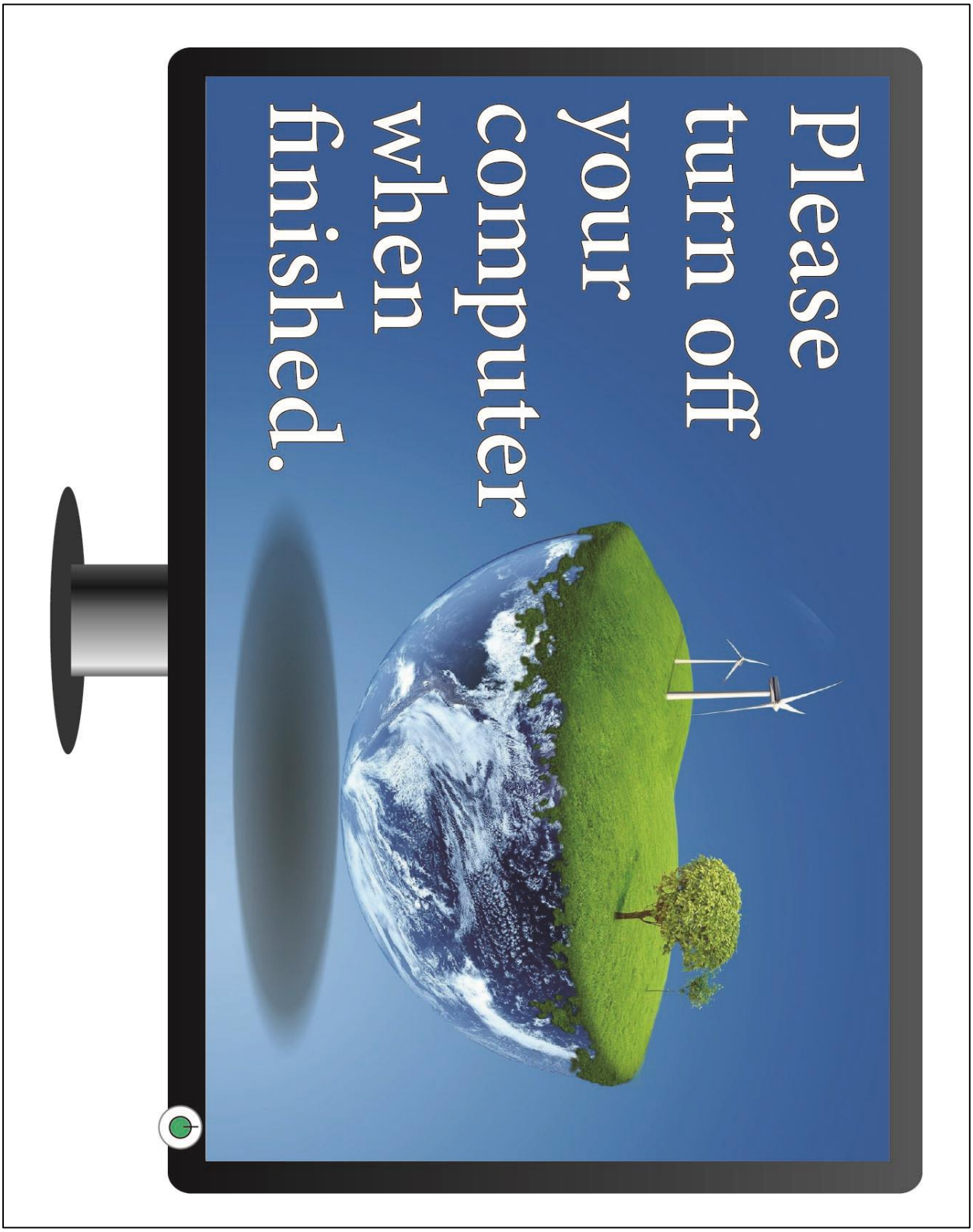
8 Appendices

Appendix A: Online Survey Questions

1. Are you a student at Dalhousie?
    a. Yes
    b. No
2. To what faculty does your program of study best correspond? Please select all that apply. Faculty of:
    a. Agriculture
    b. Architecture and Planning
    c. Arts and Social Science
    d. Computer Science
    e. Dentistry
    f. Engineering
    g. Graduate Studies
    h. Health Professions
    i. Law
    j. Management
    k. Medicine
    l. Science
    m. Sustainability
3. Please indicate your year of study
    a. 1
    b. 2
    c. 3
    d. 4
    e. 5 (or greater, still undergraduate)
    f. Masters Program
    g. Doctoral Program
    h. Post-doc Program
4. Do you/have you used Dalhousie campus computers? (This includes the use of lab computers)
    a. Yes
    b. No
5. How often (approximately) do you use campus computers?
    a. Every day
    b. One to three times per week
    c. Two to three times per month
    d. Once every month or less
6. Once you are finished using a campus computer, do you:
    a. Log off

    b. Log off and turn off the monitor
    c. Restart the computer
    d. Log off and put the computer to sleep
    e. Turn off the computer
7. Do you perceive barriers to using computers that are turned off when you arrive to use them?
    a. It takes too long for the computer to turn on (it is an inconvenience)
    b. I see no barrier
    c. Not sure
8. What do you see as the main barriers that prevent you from turning off campus computers? (select all that apply)
    a. It takes too long
    b. I usually forget to turn off my computer
    c. I do not perceive any barrier
9. Have you seen any signs around campus computers telling you to turn off your computer after use?
    a. Yes
    b. No
    c. Not sure
10. How important is it to you to minimize your daily electricity use? (optional)
    a. 1 (not important at all)
    b. 2
    c. 3
    d. 4
    e. 5 (very important)
11. Do you have any further comments on turning off campus computers?

Appendix B: Turn Off Computer Sign



Appendix C: Ethics Proposal/Approval

UNDERGRADUATE STUDENT SUBMISSION

RESEARCH ETHICS BOARDS

DALHOUSIE UNIVERSITY

This form should be completed using the guidance document http://researchservices.dal.ca/research_7776.html

SECTION 1. ADMINISTRATIVE INFORMATION [File No: _____]

Office U Sciences and Humanities

Project Title: Changing behaviour: The effectiveness of visual prompts in creating energy-conserving behaviour amongst university students using campus computers

1.1 Student researcher: David Foster, Emma Halupka, Hannah Gillespie, Levi Kingfisher, and Rachel Shin			
Department	Environmental Science & College of Sustainability		
Degree program	Mixed		
Email	Ethics contact (David Foster): david.foster@dal.ca	Phone	902-[redacted]

I agree to conduct this research following the principles of the Tri-Council Policy Statement *Ethical Conduct for Research Involving Humans* and consistent with the University *Policy on the Ethical Conduct of Research Involving Humans*.

Student signature: David Foster Rachel Shin

1.2 Supervisor Name: Dr. Hendricus Van Wilgenburg			
Department			
Email	hwilgenb@dal.ca	Phone	

I have reviewed the attached ethics application prior to its submission for ethics review, including the scientific/scholarly methods of the research project which is described in the ethics application, and believe it is sound and appropriate. I will ensure this research will be conducted following the principles of the Tri-Council Policy Statement *Ethical Conduct for Research Involving Humans* and consistent with the University *Policy on the Ethical Conduct of Research Involving Humans*.

Supervisor signature: March 15, 14

1.3 Department/unit ethics review (if applicable). Minimal risk research only.
This submission has been reviewed and approved by the research ethics committee. Authorizing name and signature:

1

Date of approval:

SECTION 2. PROJECT DESCRIPTION

2.1 LAY SUMMARY [500 words]

This project aims to study the energy usage behaviour of students at Dalhousie, as it pertains to the usage of computers on campus. Campus computers are necessary for student use, but can represent a significant demand for electricity on campus. Energy consumption can be mitigated by utilizing power saving techniques either through managing the computer's settings, or encouraging energy saving behaviour among students. Power saving regimes can include programming the computers to automatically shut off, sleep, or hibernate after a period of inactivity, as well as managing monitor power status during similar periods of inactivity. Energy saving behaviour can include turning off a computer when one is done with it, turning off the monitor when not in use, putting the computer to sleep when not in use, and more.

While Dalhousie is institutionally responsible for managing their electricity consumption, students can effect change by engaging in energy saving behaviour, and our goal is to determine how to best encourage this behaviour. Two primary methods will be used to gather this information, a survey of students, and research into actual student energy saving behaviour. The survey will be open to anyone actively using campus computers, while the research will focus on members of computer lab groups from two faculties at Dalhousie.

Through this research, we will determine what motivates students to engage in such energy saving behaviour, as well as the effect of certain variables on student behaviour.

2.2 RESEARCH QUESTION

Hypothesis:

The presence of signage and initial computer state of being off will positively influence energy saving behaviour amongst students.

Research Questions:

1) What measures are currently in place, or have been attempted, to reduce electricity use by campus computers?
2) What factors influence energy-saving behaviour among Dalhousie students using school computers?
3) How does the presence of signage or culture of awareness affect energy saving behaviour?
4) Are there correlations between students from particular faculties and energy saving behaviour?

2.3 RECRUITMENT

2.3.1 Describe how many participants are needed and how this was determined.

Computer lab research:

Two computer lab using groups will be studied for the impacts of signage on their energy saving behaviour. One group will be from the Department of Biology, the other will be from the Department of Computer Science. Comparisons between the two groups will present us the opportunity to study populations in very different fields of study. For instance, we are interested in whether students in an ecology course would be pre-disposed to energy –saving behaviour due to their area of study. Including the second lab helps control for that possible bias. While ideally we would study more groups, time constraints limit the number of groups we can test.

Survey:

Individuals who are actively using computers at Dalhousie in the Killam Library Learning Commons will be asked silently to participate in our study. We will be asking approximately 200 people to participate in our study. We anticipate a high participation rate of at least 20% or more because participation will be incentivized and the survey will be very short (<10 questions). Ideally, more individuals would be asked to participate, but given funding restrictions and available timeline, 200 appears to be manageable. Assuming the undergraduate population on Sexton Campus at Dalhousie is ~10,000 students, we would need a sample size of at least 370 students to be 95% sure that they sample responses are representative of the entire population (with a confidence interval of 5) (based on the Sample Size Calculator at http://www.surveysystem.com/sscalc.htm).

Expert interviews
One or more individuals from Dalhousie's Information Technical Services (ITS) will be interviewed informally to determine the state of computers on campus, options that have been considered in the past, options that have been ruled out, and opportunities for the future. The number of individuals needed for interview will likely only be one, depending on the level of individual's expertise. We deem one expert individual to be sufficient because the information we require is objective. One person in ITS will have the same answers as any of the others.

2.3.2 Describe recruitment plans and append recruitment instruments. Describe who will be doing the recruitment and what actions they will take, including any screening procedures. Describe any inclusion / exclusion criteria.

Computer lab research:
Instructors running computer labs will be approached in person and asked for their participation in the study, along with their students. The requirements for a lab group are that they use the campus laboratory computers, and that their instructor is willing to participate. No student contact is necessary. It will be made clear to instructors that no contact or observation will be made with students, only the state of the computers after their lab has completed and the students have left. Classes which do not use campus computers are ineligible for participation in this study.

Survey:
The survey will take place primarily in the Killam Library, independently from the lab studies. Individuals who are actively using computers on campus will be silently asked to participate in our study. A brief note and link on paper will be attached to candies and distributed to those engaged in computer usage on campus. The information sheet will read:

Have a treat on us! While you enjoy this chocolate, please contribute to student research by filling out a 2 minute survey at: URL/link
Thanks!

The link will take participants to the survey hosted online. By passively engaging students through the distribution of a treat, we expect that students will feel comfortable about being asked to participate. All student computer users will be asked, regardless of age, gender, race, or other visible features. The survey itself will ask whether respondents are students, and only allow students to proceed with the survey, thus eliminating the necessity for us to directly ask individuals whether they are students.

Expert interviews
Individuals will be contacted based on their position and expertise in the field of computers at Dalhousie University. In the interest of time, individuals will be contacted by phone, at which time the purpose of our research will be explained, and they will be asked if they, or any of their peers are able to answer our questions about campus computers. They will be asked whether they are willing to provide an interview on the topic with one or more researchers, at a mutually agreeable time and place. The only requirement for

an expert to participate in the interview is that they are knowledgeable about campus computers. No other factors would exclude them, except for their willingness to participate.

2.4 METHODS AND ANALYSIS

2.4.1 Discuss where the research will be conducted, what participants will be asked to do and the time commitment, what data will be recorded using what research instruments (append copies). Discuss any blinding or randomization measures. Discuss how participants will be given the opportunity to withdraw.

The study will involve three primary research methods:

Computer lab research: The impact of computer lab state will be studied in controlled experiments where two variables are manipulated prior to student arrival to a regularly scheduled lab time in two faculties. The first variable is whether the computers are on or off when the students arrive in the lab. The second variable is whether there is a sign in the lab requesting that students shut off their computers when they are finished. Students will not be engaged, observed, or contacted in any way during this part of the research. As students will not be aware of the research taking place, withdrawal of the group will be at the discretion of the laboratory instructor who will have the ability at any time to withdraw their lab group from the study. This can be carried out by contacting any of the researchers through whichever means is most convenient and expressing their desire to withdraw the lab group.

Survey: A survey will be conducted of students actively using campus computers, to determine their thoughts on saving electricity on campus, as well as barriers to their personal participation in such behaviours. This will be conducted by distributing the link to an online survey to students using campus computers, and thanking the students for participation in advance by including a reward of candy. Students who participate in the study will not be requested to supply their name or any contact information. Students who decide to participate will be enter the URL into a web browser and will be taken to an online survey asking the questions which are appended. Because survey results will be anonymous, once a participant has entered their results, there will not be a mechanism for them to withdraw from the survey, but this is not expected to be a problem given that no personal identifying information will be asked during the survey.

Expert interviews: Experts will be asked to participate in an informal, discussion based interview. As such, the questions will not be posed formally, but through discussion, we will attempt to answer the following questions:

1) What is the state of computers on campus as they pertain to energy saving features and settings?
2) What options are there for energy savings with campus computers?
3) What options have been considered but rejected for energy saving on campus computers?
4) What opportunities are there in the future for energy savings on campus computers?

Results from interviews will be used in the discussion of our lab research and survey results, and will not undergo statistical analysis.

2.4.2 Describe your role in this research and any special qualifications you have that are relevant to this study (e.g. professional experience, methods courses, fieldwork experience).

All researchers will be involved in all stages of the research including planning, execution, and analysis. The researchers in this group come from a wide variety of backgrounds and have expertise in biology, economics, environmental science, sustainability and more.

2.4.3 Describe plans for data analysis in relation to the hypotheses/questions/objectives.

Computer lab research
Data from computer lab research will be compared to see whether there is a difference between the number of computers left on given the initial state of the computers upon lab arrival, and the presence of a sign. Furthermore, the results from the two study groups will be compared to determine if there is a difference between the students in a life sciences course, and those in a computer science course.

Survey
Data will be analyzed to see if respondents already engage in energy saving behavior, and if they perceive any barriers to doing so. This will address the question of other factors which influence energy saving behaviour in students. How so and how will it be represented?

Expert interviews
No formal data analysis will take place of these results.

2.4.4 Describe and justify any use of deception or nondisclosure and explain how participants will be debriefed.

Computer lab research
Students in lab groups will not be aware that they are participating in behavioral research. This is necessary because if they were aware, they would likely respond differently. Laboratory instructors will be given the opportunity to discuss the study with researchers beforehand, ask questions, and assess the risk to student participants. It is up to the discretion of the instructors whether students are debriefed on the study, but this will necessarily have to be after the students have left the computer lab so as to not affect the behaviour of students.

Survey
N/A

Expert interviews
N/A
☐ Not applicable

2.4.5 Describe any compensation, reimbursement or incentives that will be given to participants (including those who withdraw).

Computer lab research
N/A

Survey:
Students who are asked to participate will be given an incentive prior to their participation in the survey. Whether or not they choose to participate, they will receive the chocolate as a thank you for considering being a part of our research. No other compensation will be given and the same applies to expert interviews.

Expert interviews
Experts will be thanked for their participation and will be offered a copy of our research at the completion of our work.
☐ Not applicable

2.5 INFORMED CONSENT PROCESS

Describe the informed consent process (i.e. how and when the research will be described to the prospective participant and by whom, how the researcher will ensure the prospective participant is fully informed of

what they will be asked to do). If non-written consent is proposed, describe why and the process. If a waiver of informed consent is sought, address the criteria in the guidance document and TCPS articles 3.7 and/or 5.5. Address how any third party consent (with or without assent) will be managed. Describe any plans for ongoing consent, and/or community consent. Discuss how participants will be given the opportunity to withdraw (their participation and/or their data, and any limitations on this).

Append copies of all consent forms or any oral consent script.

2.6 PRIVACY & CONFIDENTIALITY

2.6.1 Describe how data will be stored and handled in a secure manner, how long data will be retained and where, and plans for its destruction.

Computer lab research
Results from our computer lab study will be kept in hard copy, in a locked filing cabinet at the home of one of the researchers (specifically, at Emma Halupka's house) for five years (as per University requirements). Any digital data will be encrypted, and stored on a memory stick which will be physically stored in a locked filing cabinet at the home of one of the researchers; this data will be retained for five years.

Survey
The survey data will be downloaded and analyzed, then stored digitally using the same encryption and physical security as the lab research results. Online data will be deleted after all responses are collected to ensure the results are not continuously available on the internet.

Expert interviews
A voice recording of interviews will be kept using the same encryption and physical security as the lab research results. Hard copies of interview notes will be stored securely in a locked filing cabinet at the home of one of the researchers. After five years, they will be shredded before discarding.

2.6.2 Address any limits on confidentiality, such as a duty to disclose abuse or neglect of a child or adult in need of protection, and how these will be handled. Such limits should be described in consent documents.

Expert interviews
The interview section is component of our research that might identify the participants who contribute to our research. We cannot offer anonymity or confidentiality within publications because their participation in our research is contingent upon their relevant expertise, and these individuals will be made aware of this fact before the interview. If an individual is uncomfortable being named within our interviews, we would ask them to identify a peer who might be willing to provide responses and allow us to use their name in publications.
☐ Not applicable

2.6.3 Does your use of any survey company or software to help you collect, manage, store, or analyze data mean that personally identifiable information is accessible from outside of Canada?

Survey
While the survey may be conducted on software hosted outside of Canada, no identifying information will be asked of participants. The only personal information requested will be program and year of study.
☒ No

☐ Yes. If yes, describe your use of the company or software and describe how you comply with the

University *Policy for the Protection of Personal Information from Access Outside Canada*.

2.6.4 Describe the measures to be undertaken for dissemination of research results and whether participants will be identified (either directly by name or indirectly). If participants will be quoted in reports from the data, address consent for this, including whether quotes will be identifiable or attributed. Describe how participants will be informed of results that may indicate they may be at risk (in screening or data collection), if applicable.

Research results will be published as a course-based report at the end of the semester, as well as presented to peers on campus. Only expert interviews will identify participants by name. Their consent will be sought using an informed consent form (appended). Their permission for the use of quotes will be requested on the same form, although an option for paraphrased responses will also be provided.

2.7 RISK & BENEFIT ANALYIS

2.7.1 Discuss what risks or discomforts are anticipated for participants, how likely risks are and how risks will be mitigated.

Computer lab research
Students will not be aware of their participation, will not be observed directly, studied, interviewed or interfered with in any way. For that reason we will believe there are no risks or discomforts to students associated with the study.

Survey
Students will be given the option to participate in our research, but will not be verbally asked. They will receive candy as an incentive whether or not they participate, and hence we anticipate there will be no discomfort for participants, or those who choose not to participate. There will be no risks to participants as they will being using the computer as they normally do. In order to address food allergies, the slip of paper requesting students participate will also contain a warning about any specific ingredients contained within the chocolate which are common allergens (e.g. nuts, nut oils, etc.).

Expert interviews
Experts will be asked to discuss their field of expertise in a conversational manner. Hence, we expect there will be no discomfort for participants. Participants will be asked to discuss actions and plans of their own department at the university, and to represent their employer. They will not be asked any contentious or opinion-based questions, and hence we believe there is no risk to participants such as job related actions by their employers.

2.7.2 Identify any direct benefits of participation to participants (other than compensation), and the indirect benefits of the study (e.g. contribution to new knowledge)

While there are no direct benefits to the study participants, indirectly they may contribute knowledge about campus sustainability as it relates to computer energy use.

Computer lab research
Students in this portion of the study will not be aware that they have participated in the study, but if their instructor should choose to make them aware after the fact, our research team would gladly share the information we obtained from them through our final report.

Survey
In this portion of the study, student participants will be rewarded for considering participation with a candy,

and will have the satisfaction of contributing to their peers' research goals on campus.

Expert interviews
Participants will be contributing to a discussion about energy savings and behaviour on campus, a discussion which could ultimately inform how they conduct their department on campus.

2.8 CONFLICT OF INTEREST

Describe whether any conflict of interest exists for any member of the research team in relation to potential research participants (e.g., TA, fellow students), and/or study sponsors, and how this will be handled.

☒ Not applicable

SECTION 3. APPENDICES

3.1 Appendices Checklist. Append all relevant material to this application. This may include:

- ☐ Recruitment Documents (posters, verbal scripts, online postings, any invitations to participate, etc.)
- ☐ Screening Documents
- ☐ Consent Forms (see section 3.2 below)
- ☐ Research Instruments (questionnaires, surveys, interview or focus group questions, etc.)
- ☐ Debriefing Forms
- ☐ Permission Letters (Aboriginal Band Council, School Board, Director of a long-term care facility)

3.2 Consent Form

Guidance on the information to be provided in the consent form is described in *Guidance for Submitting an Application for Research Ethics Review – Undergraduate Students,* available on the Research Ethics website.

A sample consent form follows and may be used in conjunction with the information in the *Guidance* document to help you develop your consent form. Remember to use clear, simple language (grade 8 comprehension level and no technical jargon or acronyms) in a readable font size.

DALHOUSIE UNIVERSITY
Inspiring Minds

INFORMED CONSENT FORM
Expert Interviews

Project Title: Changing behaviour: The effectiveness of visual prompts in creating energy-conserving behaviour amongst university students using campus computers

We invite you to take part in a research study being conducted by David Foster, Emma Halupka, Hannah Gillespie, Levi Kingfisher, and Rachel Shin, who are students at Dalhousie University, part of the class ENVS3502, Campus as a Living Laboratory. Taking part in the research is strictly voluntary and you may withdraw from the study at any time without penalty or refuse to answer any questions. Your decision will not affect your employment, if you decide not to participate in the research. The information below explains what you will be asked to do and about any benefit, risk, or discomfort that you might experience. You should discuss any questions you have about this study with David Foster, the ethics contact person in this research group. You may also contact the course instructor, Dr. Hendricus Van Wilgenburg (hwilgenb@dal.ca) if you have any further questions.

Who Is Conducting the Research Study

David Foster, Emma Halupka, Hannah Gillespie, Levi Kingfisher, and Rachel Shin are carrying out this research. We are students from various faculties at Dalhousie, and are all in the ENVS/SUST3502 class together and are embarking upon research into energy usage behaviour in students at Dalhousie University. The course instructor is Dr. Hendricus Van Wilgenburg. He, along with his Teaching Assistants, are supervising the research conducted by our research group.

Purpose and Outline of the Research Study

This research examines energy saving behaviour among students at Dalhousie University, and how to influence students to engage in better energy saving practices. Part of this study is a discussion with staff of the university to determine the state of computers on campus, factors in energy saving regimes, and possibilities for the future. This discussion will aid in understanding the challenges, opportunities, and future of campus computers at Dalhousie University.

Who Can Participate in the Research Study

We seek participants who are knowledgeable about campus computers. Specifically, we are wish to discuss the state of computers on campus (as relates to energy saving), opportunities that have been examined in the past, options which have been declined, and opportunities for the future of energy efficient computing at Dalhousie. Anyone is eligible for participation in this study, provided they have the relevant knowledge about campus computer usage.

What You Will Be Asked to Do

To help us understand the state of computers on campus, you will be asked to have an informal discussion about this topic with one or more researchers, at a mutually agreeable time and place. No preparation is necessary, unless you feel there is some specific information you wish to provide which you believe would be beneficial to our study.

Possible Benefits, Risks and Discomforts

Participation in this research will contribute to the overall knowledge of energy saving behaviour in students at post-secondary institutions. You may not benefit directly from participation in this research; however, our findings may encourage the development of regimes that are both energy saving, and acceptable to the user of computer equipment.

You will not be asked to provide any contentious opinions or information which may compromise your relationship with your employer. We anticipate there should be no risks to you as an employee of the university. We wish to assure you that we seek an informal interview which is comfortable and conversational and should provide no discomfort.

Compensation / Reimbursement

You will not receive any compensation for participating in this study. We would gladly provide you or your department with a copy of our findings in early April 2014.

Privacy and Confidentiality

The information that you provide to us will be used in a final term paper, and an in class presentation. We may wish to use your name in publications because your status as an expert gives credibility to our research, findings, and conclusions. If you wish, your answers can be paraphrased instead of the use of direct quotes. The data will be stored for the duration of the project and destroyed of after the study. Confidentiality will be provided to the fullest extent possible.

If You Decide to Stop Participating

You are free to withdraw from the study at any time. If you decide to stop participating at any point in the study, you can also decide what specific information you provided should be removed, and what can remain in the study. You will have up to one week should your wish to remove your data. After that time, it will become impossible for us to remove it because it will already be a crucial component of our research findings.

How to Obtain Results

We will provide you with a short description of group results when the study is finished. No individual results will be provided. You can obtain these results by contacting us at the beginning of April.

Questions

We are happy to talk with you about any questions or concerns you may have about your participation in this research study. Please contact David Foster (at 902 880-8712, david.foster@dal.ca) or Dr. Hendricus Van Wilgenburg (hwilgenb@dal.ca) at any time with questions, comments, or concerns about the research study. We will also tell you if any new information comes up that could affect your decision to participate.

If you have any ethical concerns about your participation in this research, you may also contact Catherine Connors, Director, Research Ethics, Dalhousie University at (902) 494-1462, or email: ethics@dal.ca

DALHOUSIE UNIVERSITY
Inspiring Minds

INFORMED CONSENT SIGNATURE

Changing behaviour: The effectiveness of visual prompts in creating energy-conserving behaviour amongst university students using campus computers

I, _____ have read the explanation about this study. I have been given the opportunity to discuss it and my questions have been answered to my satisfaction. I agree to take part in this study. However I realize that my participation is voluntary and that I am free to withdraw from the study at any time, including up to one week after my interview date.

Furthermore, I recognize that none of the following options are required for participation in the study, and I give permission (check or "x" all that apply):

- ○ To have my interview recorded by audio recorder

- ○ To be included by name in the "acknowledgements" section of any publications

  Name: _____

  Title: _____

  Organization: _____

  (Please write your name, title, and organization above as you wish it to appear in any publications)

- ○ To be quoted in the text of any publications
  - ○ With attribution (quoted and attributed by name)
  - ○ Without attribution (quoted but not attributed by name)

Signature (participant): _____ Date: _____

Signature (researcher): _____ Date: _____

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Computer survey

1. Are you a student at Dalhousie? If yes, please indicate your year of study.
    a. Yes. Year of study: _____
    b. No

2. What faculty or faculties do your program(s) of study best correspond? Please circle all that apply. Faculty of:
    a. Science
    b. Arts and Social Science
    c. Engineering
    d. Management
    e. Agriculture
    f. Architecture and Planning
    g. Computer Science
    h. Graduate Studies
    i. Dentistry
    j. Health Professions
    k. Law
    l. Medicine
    m. Sustainability

3. Do you/have you used Dalhousie campus computers? (This includes the use of lab computers).
    a. Yes
    b. No

4. If you answered "Yes" to the above question, how often (approximately) do you use campus computers?
    a. Every day
    b. One to three times per week
    c. Two to three times per month
    d. Once every month or less

5. Once you are finished using a campus computer do you:
    a. Log off
    b. Log off and turn off the monitor
    c. Log off and put the computer to sleep
    d. Turn off the computer

6. Do you perceive barriers to using computers that are turned off?
    a. It takes too long for the computer to warm up (it is an inconvenience)
    b. I see no barrier
    c. Not sure

7. What do you see as the main barriers discouraging you from turning off campus computers? (circle all that apply)
    a. It takes too long
    b. I usually forget to turn off my computer
    c. I do not perceive any barrier

8. Have you seen any signs around campus computers telling you to turn off your computer after use?
    a. Yes
    b. No
    c. Not sure

9. How important is it to you to minimize your daily electricity use? Please circle one.
    1. Not important at all
    2. Somewhat unimportant
    3. Neutral
    4. Somewhat important
    5. Very important
    6. No response

Thank you for participating in our survey!

Appendix D: Project Schedule

Table 8.1 Schedule for project execution and completion.

Task/Description	Time Frame	Roles/Responsibilities
(1)Draft Proposal Includes: ethics application submission for approval	Week 1 (Feb 23- Mar 1) Project Proposal Due - Feb27	Complete
(2)Signage Collaborative brainstorm for signage design Creation of sign (3)Observational study Test #1- administer treatment to BIO 2060 class in LCS biology computer lab, 2 hour lab session (4)Literature Review Ongoing process	Week 2 (March 2 – 8)	Signage -brainstorming (collective group effort) -creation (Hannah) Observational Study -ongoing process/interchangeable sessions -Prior treatment set up in labs/treatment application (Hannah) -Cleanup/data collection after lab session (Rachel, Hannah) Literature Review -ongoing (collective group effort)
(5)Observational Study Test #2- administer treatment to Computer Science (CS) class in CS laboratory, CSCI 1101 – 3hour lab session, CSCI 2060 – 2/3 hour sessions (6) Interview with member of IT department Form interview questions Conduct interview Compile results/analysis/comprehension (7) Pilot survey Question finalization(partially complete) Implementation of pilot test (distribution and attaining) analysis/comprehension of survey Revising survey questions	Week 3 (March 9 – 15)	Observational Study -ongoing process/interchangeable sessions -Prior treatment set up in labs/treatment application (Levi) -Cleanup/data collection after lab session (David, Emma) Interview with member of IT department -formation of questions (David) -conduct interview (Levi, David) -Result analysis/comprehension (Rachel, Hannah, Emma) Pilot survey -finalize questions (partially complete) (Levi, Emma) -launch of pilot survey (collective group effort) -analysis of pilot results (Hannah, Emma) -revise survey questions (Levi)
(8) Survey Preparation (create handouts) Survey promotion/distribution (hand out of links to online survey)	Week 4 (March 16 – 22)	Survey -preparation (Rachel, David) -promotion/distribution (collective group effort)
(9) Post experiment/survey data collection, analysis and synthesis Identify gaps in research conducted	Week 5 (March 23 – 29) Presentation	Data collection, analysis, synthesis -collection (Emma, Levi, Rachel) -gap revision (Hannah, David)

Task/Description	Time Frame	Roles/Responsibilities
Revision of research question/frame/design Further information gathering (for gaps identified)	Slides Due - Mar 29	-further information gathering (collective group effort)
(10) Writing Report Draw conclusions from results Formulate findings/results/discussion/ recommendations Finalize literature review (11) Making of Presentation Slide preparation in Pecha Kucha style/ preliminary slides submission Practice Present	Week 6 (March 30 – April 5) Presentation slides due Mar-29 Presentation Date - April 1	Writing report -collective group effort, specific distribution of responsibilities to be determined Making of Presentation -slide preparation (Rachel, Levi, Emma) -practice/present (collective group effort)
(12) Edit Report (13)Final Report and Stewardship of the Process Submission	Week 7 (April 6 – 11) Final Report/ Stewardship Process Due-April 11	Edit Report -collective group effort Submission (to be determined) Stewardship of the Process -individual process

Appendix E: Project Communication Plan

Item	Involvement	Purpose	Frequency/ date	Methods
Project planning meetings	Group members	Design the experiment, decide on schedule, methods, deliverables, etc.	Regularly scheduled in and out of class time	Meetings
Project planning consultations	Group members and teaching assistant	Clarify details of assignment and obtain guidance	Regularly in class	Meetings
Status updates	Group members	Address issues promptly as they arise	As needed	Email, personal communications
Project check-ins	Group members & teaching staff	Address technical issues needing instructor feedback as they arise	As needed	Email
Initial contact with research facilitators	Communication coordinator and potential facilitators	Recruit laboratory instructing staff in the research process to study student computer power usage behaviour	Late February, once per facilitator	Email
~~**Initial contact with Dalhousie Information Technical Services staff**~~	~~Communication coordinator and ITS staff~~	~~Recruit ITS staff who are able to knowledgeably discuss computer power usage on campus~~	~~Late February~~	~~Phone~~
Meeting with research facilitators	Group members and research facilitators	Discuss details of the study and requirements of facilitators	Early March, once per facilitator	Meetings
Meeting with ITS staff	Group members and ITS staff	Determine the state of computer power usage on campus	Early March, once	Meeting
Presentation to class	Group members	Present findings of study to classmates	End March	In-class presentation