MANAGING WATER AND ELECTRICITY CONSUMPTION IN UNIVERSITY RESIDENCE HALLS: A STUDY ON PROMOTING VOLUNTARY RESOURCE CONSERVATION BY COLLEGE STUDENTS

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Abstract

With the world's population growing at a rate faster than the rate at which natural resources are being replenished, the challenge for governments and the world's citizens is how to conserve resources in order to provide a sustainable level of natural resources for the future. Conserving natural resources includes educating the citizens of the world on the connection between natural resource depletion and their levels of consumption of resources, such as energy and water.

To help alleviate the increasing burden the world's growing population is placing on natural resources, sustainability should be a part of college students' education in their field of study and in preparing them to become good citizens. This education should take place in the classroom and other activities, including athletics, community organizations, and in their residence life. Teaching students living in on-campus residence halls conservation activities provides information that students can use in their private lives when setting up their own households. On-campus residence halls also provide an opportunity to evaluate any gender differences related to conservation activities since the demographics of the residence halls vary from all-female, to co-ed, to all-male students.

Virginia Polytechnic Institute and State University (Virginia Tech) was the location for a study on promoting environmentally-relevant behavior (ERB) among students residing in on-campus residence halls. The objective of this study was to investigate the relationship between the use of educational strategies and natural resource consumption by promoting ERB among students living in the residence halls during the spring and fall semesters of the 2009 calendar year.

Using the literature on promoting ERB, five different strategies were designed for promoting water and electricity conservation. Each strategy involved different stimuli to promote student participation in ERB. The information provided the students included reasons why ERB was important and specific actions to take to conserve resources. In three of the strategies, students were provided the results of their conservation efforts monthly during the study period.

The Virginia Tech Office of Residence Life provided detailed information for the 49 on-campus residence halls, including buildings' characteristics such as heating and cooling methods, age, construction, renovation history, square footage, if the buildings contained offices or classrooms, and student population figures. Variability among the buildings was eliminated by comparing these differences, and then a random numbers table was used to assign each of the buildings to one of the five different groups. The strategy for each group was applied to four residence halls -- two dormitories and two Greek Houses, for a total of twenty buildings. In each strategy more stimuli were applied in an effort to produce higher consumption reductions.

The Virginia Tech Office of Facilities provided four-years historical electricity and seven-years historical water usage, and provided monthly usage for each building during the study period. Electricity consumption reduction was promoted in all twenty halls but water consumption reduction was promoted only in the dormitories, as the University was unable to track water consumption for any one individual Greek House. The historical data showed that water usage per student was higher in most of the female-occupied dormitories, but no statistical difference was seen with regards to historical electricity usage and gender. Percent change in per student usage – kilowatt hours for electricity and gallons for water – was the calculation used to determine change in ERB.

The results of this research showed a general relationship between educational strategies and natural resource consumption reduction over both study periods. However, except for the Greek-House Spring semester results, no statistical significant difference was found between any of the different study groups. Electricity reductions were achieved in seventeen of twenty residence halls during the first semester and in all but one residence hall during the second semester. Water reductions were achieved in five of ten dormitories during the first semester and in six of nine dormitories in the second semester. However, the use of more strategies did not lead to a higher percentage of reductions.

During the first semester, a statistically significant difference was found in water usage and gender and the difference did not support a female predisposition for ERB. Decreases were achieved in excess of 10% in the male-occupied dormitories, but only a minimal reduction or increases were achieved in any of the dormitories that included female residents. After the first month of the second semester, similar results were seen relative to gender, so additional posters and prompts were placed in the female-occupied dormitories. As a result, water reductions were achieved in six dormitories with only small increases in the other three, and the semester final results did not show a statistical significant difference between genders.

The lack of statistical difference between the study groups could be a result of contamination, the active environmental organizations on campus, or an observational effect. The study was contaminated within the first two weeks of the study period when all residence halls across campus learned of the research and requested their inclusion in the study. Since, the residence halls in the control groups were advised of their inclusion in the study, the students may have demonstrated ERB because of the knowledge they were being observed.

A survey sent to the students living in the study residence halls revealed that 94.6% of the students had knowledge of the study, and that 77% participated in ERB. Students showed a propensity for ERB when they were informed on their consumptive behaviors' effects on natural resource depletion, and by being provided with actions they could take to change their behaviors. This research did not show that adding strategies of feedback and group leaders to information increased the percentage of consumption reductions in college students residing on Virginia Tech's campus.

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Chapter 1: Introduction and Statement of Purpose

1.1 Introduction

Environmental sustainability is a priority of the United Nations. "Special attention should be paid to the demand for natural resources generated by unsustainable consumption and to the efficient use of those resources consistent with the goal of minimizing depletion and reducing pollution" (United Nations 1992). With the world human population estimated to reach 9.2 billion people by 2050 (United Nations 2007), the challenge is how to conserve the earth's resources to sustain and meet the needs of the world's rising population at current or past per capita consumption rates, and to reduce or eliminate the increasing demands of the affluent.

The Earth is a closed system, meaning resources are limited to what is available within or upon the earth itself. In the 1960s, experts estimated the Earth's carrying capacity for natural resource consumption at 5.5 billion people, a population level reached in the early 1990s (Dailey and Ehrlich 1992). However, with advances in technology and the growing environmental awareness that began in the 1970s, the earth has sustained a population beyond that figure (Moore 1999), although advocates of population control dispute this statement (Ehrlich and Ehrlich 1990; Brown 2003). Despite this contradiction in opinions, at current consumption levels, many experts agree that without environmentally-relevant behavior (ERB), we will eventually reach the earth's carrying capacity (Orr 2000; Oskamp 2000; Trauger 2001).

The U.S. population is the greatest per capita consumer of natural resources in the world. The U.S. population represents only 5% of the world's population yet consumes approximately 25% of its natural resources (Oskamp 2000). Some environmental organizations have estimated that 1985 was the last year in which the world's consumption did not exceed the production of natural resources (Earthsky 2009; ICLEI 2009; Twentyten 2010). Each year since that time, the day that the world's consumption exceeded production (Earth's Overshoot Day) has progressed earlier in the year. (Table 1.1)

Table 1.1 Progression of Earth's Overshoot Day

Year	Overshoot Day
1986	December 31, 1986
1995	November 21, 1995
2005	October 2, 2005
2007	October 7, 2007
2008	September 23, 2008
2009	September 24, 2009

(Data Source: Earthsky 2009; ICLEI 2009; Twentyten 2010)

Universities and colleges are not immune from this over-consumption. A U.S. Department of Energy study (1993) revealed buildings at colleges and universities represented 5% (77,000 out of 1,497,000) of total buildings at multi-building facilities in the U.S. Of this, 20% of university buildings (or 1% of the U.S. multi-building total) are residential buildings. Yet, despite being only a low percentage of multi-building facilities, colleges and universities consume 18.6 % (541 trillion BTU out of 2,901 trillion BTU) of the total energy use for all multi-building facilities in the U.S. (U.S. Department of Energy 1993). (Figure 1.1)

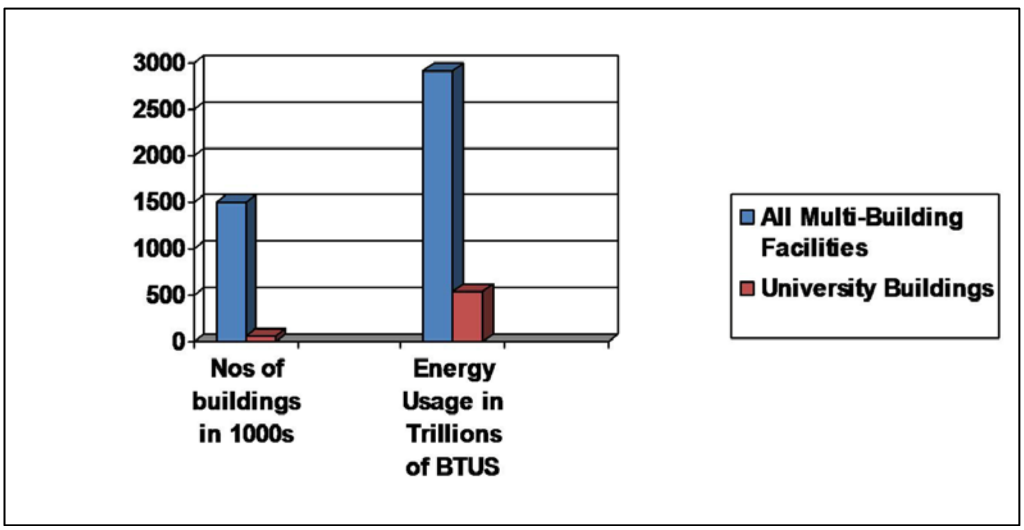

Figure 1.1 Energy Usage in Multi-Building Facilities
(Data Source: U.S. Department of Energy 1993)

In 2006, Virginia Polytechnic Institute and State University's (hereinafter referred to as "Virginia Tech") energy use was 3.0 trillion BTU out of a total of 8.56 trillion BTU (or 35%) in the Town of Blacksburg (Randolph et al. 2007) (Figure 1.2). Virginia Tech's central campus, located in Blacksburg, contains 170 buildings, of which 49 buildings (29%) are residence halls. Energy usage in residence halls on Virginia Tech's campus includes heating and cooling, heating water, and electricity for various uses - lighting, small and large appliances, and students' personal equipment. But in 2006, only 8,930 students lived in these on campus residence halls (Belcher 2008), a small percentage of the over 26,000 students enrolled (Young et al. 2007). So Virginia Tech's impact on energy usage in the Town is much higher than that 35% figure.

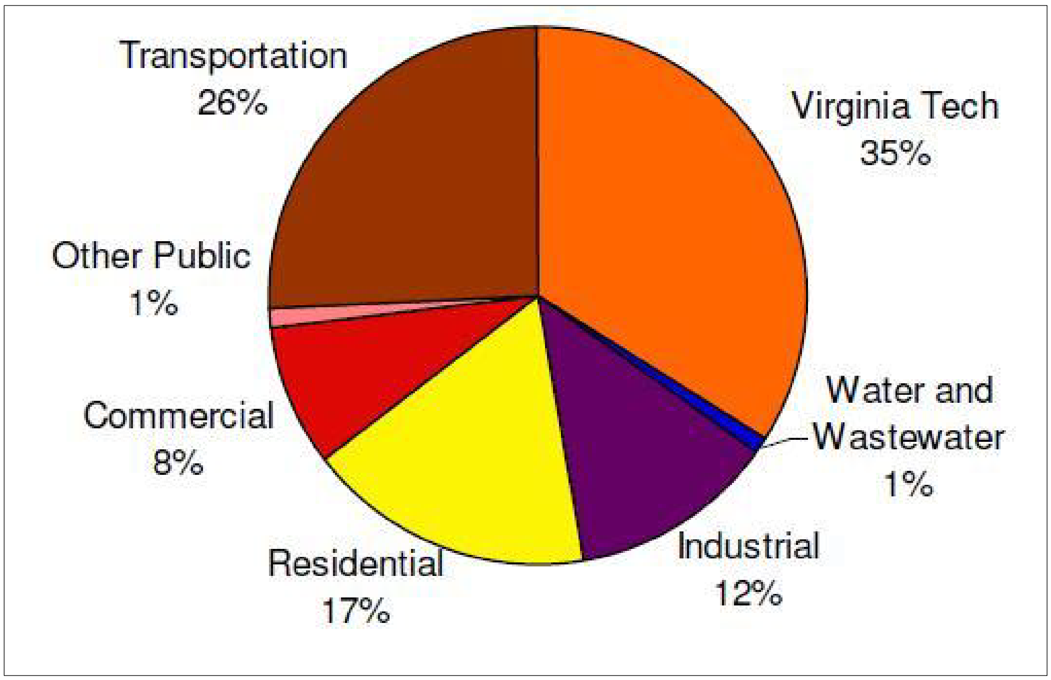

Figure 1.2 Distribution of Energy Use within the Town of Blacksburg
(Used with Permission of Randolph et al. 2007)

Virginia Tech and other universities have an opportunity to lessen the human impact on the earth by changing their levels of natural resource consumption. By serving multiple roles in the community – education, service, and experts and leaders on a variety of subjects and issues (Geiser 2006), universities are instruments of social change (Wright 2004). Boyer (1990, 1996) advocates universities directly help in the monumental issues facing the world community, and providing leadership in environmental sustainability certainly qualifies (Martin and Jucker 2005; Geiser 2006; Albrecht et al. 2007). Experts suggest promoting sustainability in higher education can be accomplished by incorporating environmental issues in curricula, by upgrading and changing operations, and by helping students understand the causes of environmental issues and injustices (Clugston 2000; Clugston and Calder 2000; Chalkley 2006; Koester et al. 2006). This understanding comes from more than classroom learning, as experts advocate universities should provide opportunities for students to learn and implement ERBs (Geiser 2006; Kagawa 2007).

Virginia Tech advocates this community service in its formal policies. In its Mission Statement, Virginia Tech "creates, conveys, and applies knowledge to expand personal growth and opportunity, advance social and community development…and improve the quality of life" (Virginia Tech 2006). Virginia Tech's Strategic Plan includes social and environmental changes as part of its social individual transformation goals, along with innovative research in sustainable energy. Virginia Tech is on the cusp of implementing operational, maintenance, and construction changes in an effort to reduce its energy consumption and combat rising energy costs (Cochrane 2008).

Yet, student organizations lament that promoting ERB among students residing on campus is one of the areas lacking in the initial phases of Virginia Tech's sustainability activities. Informing and educating students living in university residence halls on why and how to conserve natural resources, and how to live sustainably would meet the formal policies of Virginia Tech and the call of experts to implement environmental issues in the education of students. Such considerations suggest examining the impacts of promoting ERB in college students residing on the Virginia Tech campus is worthy of analysis.

1.2 Statement of Purpose

This study investigated how the electricity and water consumption behavior of students living in Virginia Tech residence halls changed in response to various educational strategies. These strategies included information through presentations, posters and emails, and voluntary resource conservation activities and were applied at varying levels of intensity across five study groups. Strategies applied within each study group were the same regardless of the gender of the students in the residence hall (male, female, or co-ed).

The first basic research focus of this study was the relationship between education and the consumption of natural resources. The second basic research question was the influence of gender on ERB. The applied research application was two-fold. First, this study focused on reducing natural resource consumption in groups of individuals who only have decision-making power over behavior, have no financial incentive for conserving resources, and have no input into efficiency of appliances, building renovations, or university operations. Second, this study will assist Virginia Tech officials in developing the best strategies to encourage students living on campus to conserve water and electricity, which will ultimately result in University cost savings and reduction of its carbon footprint.

Research Questions: *First, will different levels of intensity of educational strategies produce different levels of reduction in electricity and water consumption when the users are students who are transient individuals and who will experience no financial impact whether they consume more or less? Second, can their attention be focused on ERB by appealing to their sense of altruism and ecocentricism and thus reducing their consumption of natural resources? And, third, does the gender of the residents influence a variation in the levels of reduction?*

This research can serve several purposes. The first is to inform Virginia Tech officials of strategies to reduce natural resource consumption in the residence halls. The strategies could also be used as part of their sustainability action plan, and may also be tested on faculty and staff to reduce consumption levels in all university buildings. The results will be made available to the active student organizations on campus interested in environmental issues and promoting ERB. The research can add to the literature about natural resource conservation at the organizational level, but most specifically, help supplement the dearth of information on changing ERBs in group residential settings. Finally, individuals in the residence halls will have increased awareness of their contribution to natural resource depletion, and the students participating in this study will continue the learned conservation behaviors when they leave the university, become independent citizens, and future parents.

This research also has several educational applications. It can be used in a classroom setting to educate geography students that the scope of the human-environment tradition includes conservation and natural resources, as well as to educate other social science students on strategies to promote ERB. It could also be used for educating students in a sustainability curriculum, showcasing the successes and failures of instilling ERB in individuals, as well as demonstrating interdisciplinary cooperation in a university. This study could also be used as a basis for a service-learning course in which the students participate in conservation education and focus on the importance of natural resource protection.

1.3 References

Albrecht, P., S. Burandt, and S. Schaltegger. 2007. Do sustainability projects stimulate organizational learning in universities? *International Journal of Sustainability in Higher Education* 8(4):403-415.

Belcher, K. 2008. Associate Director of Occupancy Management - Virginia Polytechnic Institute and State University. October 15, 2008

Boyer, E. L. 1990. *Scholarship reconsidered: Priorities of the professoriate*. Princeton, NJ: The Carnegie Foundation for the Advancement of Teaching.

Boyer, E. L. 1996. The scholarship of engagement. *Journal of Public Service and Outreach* 1(1):11-20.

Brown, L. 2003. Rescuing a planet under stress. In *Taking sides: Clashing views on controversial environmental issues, 10th Edition,* eds. T. A. Easton and T. D. Goldfarb, 216-223. Guilford, Connecticut: McGraw-Hill/Dushkin.

Chalkley, B. 2006. Education for sustainable development: continuation. *Journal of Geography in Higher Education* 30(2):235-236.

Clugston, R. M. 2000. Introduction. In *Sustainability and university life, 2nd revised edition,* ed. W. L. Filho, 11-18. New York: Peter Lang Publishing.

Clugston, R. M. and W. Calder. 2000. Critical dimensions of sustainability in higher education. In *Sustainability and university life, 2nd revised edition,* ed. W. L. Filho, 31-46. New York: Peter Lang Publishing.

Cochrane, D. C. 2008. Energy and Sustainability Coordinator – Virginia Polytechnic Institute and State University Office of the Associate Vice President of Facilities. Interviewed on September 12, 2008 at Blacksburg, Virginia.

Dailey, G. and P. E. Ehrlich. 1992. Population, sustainability, and earth's carrying capacity: A framework for estimating population sizes and lifestyles that could be sustained without undermining future generations. *Bioscience 112*. Accessed on August 17, 2008 at http://dieoff.org/page112.htm

Earthsky. 2009. Accessed on January 24, 2010 at http://www.earthsky.org/blogpost/earth/september-25-is-earth-overshoot-day-for-2009

Ehrlich, P. E. and A. H. Ehrlich. 1990. *The population explosion*. New York: Simon and Schuster.

Geiser, K. 2006. Education for a transition to sustainability. In *Inside and out: Universities and education for sustainable development,* eds. R. Forrant and L. Silka, 29-40. Amityville, NY: Baywood Publishing.

ICLEI. 2009. Local Governments for Sustainability. Accessed on January 24, 2010 at http://www.iclei.org/index.php?id=10430

Kawaga, F. 2007. Dissonance in students' perceptions of sustainable development and sustainability: Implications for curriculum change. *International Journal of Sustainability in Higher Education* 8(3):317-338.

Koester, R., J. Eflin, and J. Vann. 2006. Beyond disciplines: integrating academia, operations and community for campus wide education for sustainability. In *Inside and out: Universities and education for sustainable development,* eds. R. Forrant and L. Silka, 41-61. Amityville, NY: Baywood Publishing.

Martin, S. and R. Jucker. 2005. Educating earth-literate leaders. *Journal of Geography in Higher Education* 29(1):19-29.

Moore, S. 1999. Body count. In *Taking sides: Clashing views on controversial environmental issues, 10th Edition*, eds. T. A. Easton and T.D. Goldfarb, 224-230. Guilford, Connecticut: McGraw-Hill/Dushkin..

Orr, D. W. 2000. Transformation or irrelevance: The challenge of academic planning for environmental education in the 21st century. In *Sustainability and university life, 2nd revised edition*, ed. W. L. Filho, 219-232. New York: Peter Lang Publishing.

Oskamp, S. 2000. Psychological contributions to achieving an ecologically sustainable future for humanity. *Journal of Social Issues* 56 (3):373-390.

Randolph, J., D. Pitt, and students of UAP 5794/4794 and UAP 4394. 2007. Blacksburg energy and greenhouse gas emissions study: Report to the mayor's task force on sustainability and climate change, Sustainable Blacksburg Steering Committee and Virginia Tech Committee on Energy and Sustainability. Unpublished.

Trauger, D. L. 2001. Human population growth and environmental carrying capacity. Presented at a panel discussion entitled Population Issues: Demographics, Policy and Environmental Linkages. Izzak Walton League of America 2001 National Convention. Fort Mitchell, KY. July 13, 2001.

Twentyten. 2010 Biodiversity Indicators Partnership. Accessed on January 24, 2010 at http://www.twentyten.net/news/earthovershootday

United Nations. 1992. Department of Economic and Social Affairs, Division of Sustainable Development. *Agenda 21*. Last updated 15 December 2004. Accessed on August 17, 2008 at http://www.un.org/esa/sustdev/documents/agenda21/

United Nations. 2007. Department of Economic and Social Affairs, Population Division. *World population prospects: The 2006 revision, highlights*. Accessed on August 17, 2008 at http://ww.un.org/esa/population/publications/wpp2006/WPP2006_Highlights_rev.pdf

U. S. Department of Energy. 1993. Assessment of energy use in multi-building facilities. Accessed on August 23, 2008 at http://www.eia.doe.gov/emeu/cbecs/archive/arch_hist_pubs/cbecs_pdf/DOE%20EIA-0555(93)-1.pdf

Virginia Tech. 2006. Virginia Polytechnic Institute and State University Mission Statement and Strategic Plan. Last updated 2006. Accessed on August 23, 2008 at www.vt.edu.

Wright, T. 2004. The evolution of sustainability declarations in higher education. In *Higher education and the challenge of sustainability: Problematics, promise and practice*, eds. P. B. Corcoran and A.E. Wals, 7-20. Dordrecht, Netherlands: Kluwer Academic Publications.

Young, M.L., A. Bailey, and L. O'Brien. 2007. Designing a user-centric catalog interface: A discussion of the implementation process for Virginia Tech's Integrated Library System. *Virginia Libraries* October/December 2007:11–15.

Chapter 2: Literature Review

2.1 Introduction

This chapter, which provides a review of the literature, consists of eight sections. The first section provides support for this research's relevance under geographic pedagogy and identifies a gap in geographical research. The second part reviews the literature from other disciplines that pertains to models and theories promoting environmentally-relevant behavior (ERB) and pinpoints those models and theories applicable to this research. The third argues that long-term reductions in natural resource consumption are only achievable through changing ERB.

The next two sections identify the field-based research on ERB; specifically the large volume of research found at the household-scale of analysis concerning both energy and water consumption and the limited research at the organizational or institutional level are assessed. Next, analysis of gender impacts on natural resources and environmental issues is briefly discussed. The second to last section reviews the literature supporting the methodology and statistical analysis used in this research. The final section provides a brief summary of all the literature, emphasizing the gaps that provide the inspiration for this research.

2.2 Relevance to Geography

Human-environment interaction is a traditional theme in geography (Pattison 1964), and the one tradition in which the National Council for Geographic Education specifically references in its position statement on Geo-literacy (National Council for Geographic Education 2010). Environment and Society is one of the Eighteen Standards of Geographical Education and includes human modification of their environment along with humans understanding the importance and usage of natural resources (Geography Education National Standards Project

1994). The study of human-environment interactions is inter-disciplinary because it encompasses anthropogenic social and economic elements along with non-human biological elements. Because geography crosses the boundaries of different disciplines (Turner 2002), it is a natural fit for human-environment research (Kates 1987; Yarnal and Neff 2004).

But does education and research on conservation and sustainability of natural resources belong under the geography umbrella? Judkins et al. (2008) state that research in the human-environment tradition encompasses a diverse range of topics and includes conservation and natural resources. Other experts argue that natural resource sustainability may be a multi-disciplinary issue, but geographers should be the leaders in sustainability education (Higgitt et al. 2005; Martin and Jucker 2005; Bednarz 2006; Chalkley 2006; Higgitt 2006). Professionals in other disciplines also believe education and research in environmental and sustainability issues belong in the field of geography (Bednarz 2006; Chalkey 2006). Natural resource issues do fall under several of "The Big Questions in Geography" posited by Cutter et al. (2002: 307), such as: "How has the earth been transformed by human action?"; "How do we measure the unmeasurable?"; and "How and why do sustainability and vulnerability change from place to place and over time?"

Yet, despite the recognition that conservation and sustainability fall within the geographic purview, few geographers have studied sustainability issues in higher education (Chalkley 2006). Over ten years after Pattison's (1964) identification of the four traditions, experts were recommending an enhanced and more in-depth study of the human-environment discipline (Robinson 1976). When reviewing a list of master's degree theses and PhD dissertations titles in the 2002 Association of American Geographers Guide, Bednarz (2006) noted a lack of graduate student research in sustainability topics.

My review of the past eleven years' issues of the *Journal of Geography* indicates that out of 292 published articles, only five articles were on education in conservation of natural resources or in sustainability issues. If general environmental topics were included, that number increases to only thirty-one, about 11% of the total articles published by this journal. In 2005 and 2006, the *Journal of Geography in Higher Education* devoted over 50% of two issues to sustainability in higher education. Yet, issues published since that time only contain one additional article on sustainability education.

Sustainability and environmental issues are multi-disciplinary in nature, and this multi-disciplinary nature fits neatly within the purview of geographical pedagogy. However, if geographers do not take leadership in this area, some geographers argue that other professionals will fill this gap in the human-environment tradition (Kates 1987; Bednarz 2006). In fact, geographers, such as Barr (2003) and Lawrence and McManus (2008), who studied conservation and sustainability issues in households, reference literature from other social sciences. To fill this gap, the literature from other social science disciplines is explored for theories and strategies related to educating college students on the relationship between their consumption and depletion of natural resources and in relation to promoting ERBs, such as water and electricity conservation.

2.3 ERB Strategies

Psychology is the discipline in which most research into human behavior and natural resource use is found. Within this literature, ERB is a concept not specifically defined because it needs little explanation – human actions or activities that impact or interact with the natural world. Psychologists argue that solving environmental problems by analyzing human behavior and influences on that behavior is logical since many environmental problems are primarily caused by human behavior (Oskamp 2000; Stern 2000; Kurz 2002; Lehman and Geller 2004). Psychologists further argue that educational strategies aimed at changing behavior should be included in our efforts at sustainability (Oskamp 2000; Abrahamse et al. 2007; Takács-Sánta 2007). A review of the psychology literature reveals that numerous theories and models exist in evaluating the promotion of ERB. A few are discussed below, and how these specific theories and models are relevant to this research is explained in the discussion.

The first perspective, social norm theory, argues that humans are social individuals who are influenced by interactions with other people. Within social norm theory is the idea that humans base their behavior on acceptable and unacceptable behaviors (injunctive norms) and on those behaviors that are most frequently used (descriptive norms). If the unacceptable behavior is the behavior most frequently used, people are most likely to conform to that behavior (Cialdini 2003; Schultz et al. 2007).

Van Raaij and Verhallen (1983), Kurz et al. (2005), and Corral-Verdugo and Frías-Armenta (2006) argue that whether or not people perform ERB is dependent on these social norms. For example, studies on littering examined behavior when an individual was in a clean versus a littered environment, and when the individual saw someone litter or use a trash receptacle. When the environment was littered, more littering occurred. When individuals saw others not littering, littering activities were infrequent (Geller et al. 1971; Finnie 1973; Geller et al. 1976; Cialdini 2003). Social norm theory is applicable to this research because in a university's residence hall, the interactions students have with each other influence their behavior. For instance, if a student sees other students turning off lights when leaving a room, they are likely to also turn off lights when leaving a room.

Influencing one person in a group setting could act as a catalyst to influence group behaviors and a second perspective, value-belief norm theory, focuses on the individual. Under value-belief norm theory, ERB is generated when people believe environmental issues threaten their values and they take action to alleviate the threat. This theory identifies three different categories of individual values: 1) egoistic, where people are focused on their own outcomes; 2) altruistic, or concern for others; and 3) biospheric, or ecocentric concern for the non-human environment (Stern et al. 1999; Schultz 2000; Hansla et al. 2008; Scherbaum et al. 2008).

University students exhibit egoistic values because they are focused on attaining a positive outcome from their studies and seek stress relief during their free time. This study intends to add the foci of altruistic and ecocentric values as students are informed on a) the causes of natural resource depletion, b) on the threat this depletion has on their life, and c) new ways to use natural resources that allow them to maintain their current lifestyle but also to sustain natural resources for the future.

A model widely discussed in the literature that can refocus individual behavior is described by Geller (1989) as the antecedent behavior and consequence model (ABC Model). This model refocuses individuals by providing them with information on the causes of natural resource depletion, on how changing their behavior will lessen their impact on natural resources but not interfere with their lifestyle, and employs techniques to change repetitive behaviors. Antecedent strategies include information and education on reasons for ERB, on the impacts of that behavior on natural resources, and on ways to change that behavior, for example - washing clothes in cold water to reduce energy consumption. A second antecedent strategy is using prompts that outline a specific behavior, for example - stickers on light switches reminding people to turn off the lights as they leave a room. Modeling or demonstrating the intended behavior, for example - a student turning off water while brushing their teeth in a residence hall's common bathroom, is a third antecedent strategy. Commitments or goal setting to the intended behavior -- for example, an agreement to reduce energy use by 10% over prior usage or reducing showering time by two minutes to conserve water and energy -- is a fourth antecedent strategy. Consequence strategies include: feedback on the results of that behavior, for example - reporting to the research participants the resulting decrease or increase in energy usage after the antecedent strategies are in use; and rewards, either positive or negative, to reinforce the behavior, for example - a pizza party for those residence halls that have a positive reduction in energy and water usage.

Researchers apply the antecedent strategies in the early stages of the research. Consequences strategies are techniques that follow antecedent strategies at some point in the research period, and consequence strategies support the behaviors being promoted. Use of the strategies based on this model can alter individual values because research participants realize that acting with ERB allows them to maintain their egoistic values, but can also include concern for others (altruistic) and the environment (ecocentric) with little impact on their lifestyle.

Implementing techniques to promote behavior change on a university campus cannot be accomplished without a specific plan of action. Such a plan of action is outlined by McKenzie-Mohr (2000) in what he describes as a step-based strategy called community-based social marketing. First, he argues, a goal must be identified. Second, barriers to the goal are determined. The third step involves designing a strategy to overcome the barriers. Next the formulated strategy is tested on a sample population. The last step involves analyzing the results of the test study prior to implementation to the entire population.

For instance, McKenzie-Mohr (2009) reported on a municipality’s goal to reduce vehicle air pollution from idling vehicles. The barriers identified were the lack of understanding by residents on the contribution to air pollution of idling vehicles, their idea that turning a vehicle on and off was “bad” for the vehicle’s engine, and how to provide the correct information dispelling these misunderstandings. The strategy developed included using signs asking drivers to turn off their engines while idling and which had a picture of a child breathing a vehicle's exhaust as well as stickers with the words "I turn my engine off while parked" given to drivers seen turning off their engines. The test study was aimed at drivers of vehicles in public transit drop-off locations and school zones. The test case produced positive results, with 73% of drivers eventually turning off their engines. Community-based social marketing is relevant to the current study because if it produces successful results in reducing energy and water usage, university administration can potentially apply the strategies in all university buildings.

The psychology literature treats these theories separately, when in fact, the theories are intertwined. Kurz (2002) suggests most psychological strategies fall into four general categories but concludes use of any one strategy alone will not alter ERB. She advocates using multiple theories and models in any study and, as is demonstrated in subsequent sections of this review, most field research uses elements of multiple theories and models when promoting ERB.

2.4 Importance of ERB

Conservation and sustainability relate specifically to human consumption rates, which are behaviors with significant environmental relevance as these rates both directly and indirectly affect natural resources (Brandon and Lewis 1999; McCalley and Midden 2002; Kurz et al. 2005). Consumption rates can be reduced by efficiency changes, which usually relate to one time or infrequent actions and to changes in technology. Efficiency changes produce immediate reductions in consumption of natural resources. Examples would include purchases of alternative fuel vehicles or Energy Star rated appliances, but they do involve an upfront monetary cost. Efficiency changes, along with regulatory requirements, have quite successfully produced decreased natural resource consumption in industries and in many products used by consumers, but most experts agree that efficiency changes will not suffice in addressing environmental issues at an individual level (Stern and Gardner 1981; Van Raaij and Verhallen 1983; Alabaster and Blair 1996; McKenzie-Mohr 2000; Stern 2000; Oskamp 2000; Lehman and Geller 2004; Abrahamse et al. 2005; Steg et al. 2006; Lawrence and McManus 2008).

Consumption rates at an individual level can be changed by curtailment initiatives. Curtailment focuses on reducing consumption through changing repetitive behavior, and experts argue that long-term sustainable reductions are achieved through modification of repetitive behavior (Stern and Gardner 1981; Geller 1989; McKenzie-Mohr 2000; Stern 2000; Lehman and Geller 2004; Abrahamse et al. 2005; Steg et al. 2006). But changing ERB is difficult in a society based on high consumption rates (McKenzie-Mohr 2000), and for some with higher incomes, wasting resources is not a concern (Seligman et al. 1981; Abrahamse and Steg 2009). Curtailment initiatives include activities such as lowering thermostats in the winter and raising them during the summer, or taking shorter showers, and these initiatives have been the focus of many research projects.

2.5 Household Scale of Analysis and Energy Conservation Research

Studies on household environmental behaviors and energy consumption are numerous. Research at this scale began with the energy crisis of the 1970s and continues to this date. Topics for household-level consumption studies include efficiency changes, but most studies have focused on curtailment initiatives (Lehman and Geller 2004; Abrahamse et al. 2005). Many of these studies applied various environmentally relevant theories and produced consumption reductions. The ABC Model is incorporated into the prevalent behavior strategy used in household-scale research, and feedback (a consequence technique) is the most frequent ABC Model technique employed. However, the procedures followed vary from study to study as did the type of feedback provided. The following paragraphs highlight examples of these studies.

Seligman and Darley (1977) used feedback in a household electricity study. An initial letter sent to households advised them of the study and requested their agreement to participate. This letter provided information that air conditioners are the largest users of electricity during summer months and to conserve electricity, reducing use of air conditioners was recommended. Those households receiving feedback on their efforts achieved a 10.5% reduction in electricity usage. Commitment, an antecedent technique, may have contributed to the study's success because agreeing to participate in the study could be deemed a commitment to implementing conservation measures.

Becker (1978) studied energy reductions using the antecedent strategies - information and goal setting, along with the consequence strategy - feedback. The household members, who were visited prior to the study, were provided a letter giving information on the energy usage of different appliances, and were asked to set one of two different conservation goals. Some of the households were provided feedback during the study. The household with the highest goal, and receiving feedback on their efforts, realized the greatest reduction in consumption, evidence that combining strategies achieves superior results.

Although Brandon and Lewis (1999) state their study is based on feedback, they actually used a combination of social norm theory, value-belief norm theory, and the ABC Model. They started with a focus at the individual level by sending a questionnaire covering environmental attitudes. Then using social norm theory, the researchers provided a letter advising each household how their own energy consumption compared with similar households in their region. Finally, using the ABC Model, six different feedback strategies were employed to determine which strategy produced the greatest reduction. Comparable reductions were achieved with three strategies - comparative, monetary and computer feedback. The other three feedback strategies actually produced increases in consumption, perhaps the result of these household conforming to the perceived social norm.

Midden et al. (1983) studied natural gas and electricity consumption using antecedent and consequence strategies, applied independently. One group was provided information only (antecedent), one group received a reward at the end of the study (consequence), and one group received feedback with information (combination – antecedent and consequence). Comparative reductions in electricity were achieved using both feedback and monetary rewards, but natural gas reductions were only achieved with the feedback technique. The control group achieved a reduction in both natural gas and electricity usage, a possible side-effect of being notified of their participation in the study, and again perhaps a result of trying to conform to the perceived social norm.

More recently, Abrahamse and Steg (2009) used Internet questionnaires to evaluate the influences of socio-demographic and psychological elements in both direct and indirect household energy use. A pre-study questionnaire was provided to the study households. Based on the responses to this questionnaire, certain households were provided with information, tailored to their household, on ways to reduce their energy use. A post-study questionnaire was used to compare pre- and post-treatment usage and personal attitudes. This study supported the view that increased consumption correlates with increased income, despite the ability of higher income households to pay for higher priced “green” products.

The majority of studies at the household level focus on reducing energy consumption. Abrahamse et al. (2005) provided a detailed summary of thirty-eight peer-reviewed household energy studies that were conducted from 1977 - 2004. These studies were focused on curtailment initiatives. Abrahamse et al. (2005) classified them by antecedent and consequence techniques and did not comment on any other applicable theories, such as social norm or value-belief norm. The authors did criticize some studies for lack of clarity on the specific ABC Model strategy used, for lack of significant sample size and statistical data, and for the inability to track long-term success of the strategies.

2.6 Household Scale of Analysis and Water Conservation Research

Water consumption is tied to household energy usage because heating water accounts for a large percentage of household energy costs (Winkler 1982). In many municipalities, household water use accounts for a large portion of total water consumption (Palmini and Shelton 1982), which further impacts energy use because treatment and delivery of water to households requires energy (U.S. Department of Energy 2006). Rogoff (1982) produced a bibliography on water conservation strategies and found sixty publications on strategies focused on using efficiency changes. Water consumption studies at the household scale using education and curtailment strategies are limited (Geller et al. 1983). A brief summary of these studies reveals the barriers to successful water conservation.

Winkler (1982) studied water consumption reduction using monetary rebates (a consequence strategy) and concluded using a rebate as an incentive to reduce consumption was ineffective. Using post-study interviews, Winkler discovered participants believed rebates would work for others, that the projected rebate would be a minimal amount due to the low cost of water, and their gardens and lawns were more valuable than the rebate.

Geller et al. (1983) promoted residential water conservation using efficiency changes, education, and behavior strategies. Efficiency methods included installing water-savings devices in toilets, showers, and kitchen faucets. Education was provided using a handbook describing wasteful behavior, the connection between energy and water, and conservation methods. Consequence strategies included daily feedback on percentage consumption followed by a weekly graph. Only the efficiency methods produced any reduction in water consumption. Geller et al. attributed the lack of success with educational and behavior strategies to the low cost of water, which, in relation to this study, could pose a barrier to water conservation in a university residence hall since students do not experience a direct monetary impact resulting from their consumption.

Taylor et al. (2004) evaluated the effect of pricing and conservation behaviors on water consumption. They found that because many water utilities include fixed costs within their water rate structure, using less water has little impact on consumer's water bills and thus, conservation programs are ineffective.

Kurz et al. (2005) promoted residential water and energy conservation using curtailment methods. Antecedent strategies implemented included prompts (labels to promote efficient use of various appliances) and information (leaflets providing the same information). The one consequence strategy used was socially comparative feedback. Only the prompts successfully produced water conservation. No energy reduction was achieved with any method. Using socially comparative feedback might have induced the participants to increase usage as a result of their attempt to conform to the social norm.

Three studies used interviews or questionnaires/surveys to investigate water use behavior. Corral-Verdugo and Frías-Armenta (2006) interviewed residents in two different cities to assess the impact of social norms on conservation of water and found a positive correlation between people with an egocentric attitude and anti-environmental behavior. Lawrence and McManus (2008) used interviews and questionnaires in a review of two sustainable lifestyle workshop programs on water consumption and concluded that the programs resulted in more careful use of water, but not necessarily to the level of sustainability. Miller and Buys (2008) used surveys to investigate water-use behavior and feelings of environmental consciousness, and they found that the two did not necessarily correlate. People reported a propensity toward water conservation, yet their actual self-reported behaviors leaned towards water wasting. These three studies show the disconnect humans have between their actions and understanding how their actions impact the environment.

2.7 Scale of Analysis - Organization/Institution

While household energy and water consumption studies are numerous, gaps exist in the literature on research aimed at promoting ERB of individuals at the institutional or organizational level (Stern and Gardner 1981; McMakin et al. 2002; Lehman and Geller 2004). Starik et al. (2002: 336) pointedly state that "while universities and colleges, like other social institutions in the business, government and non-profit sectors, can be said to have had a measure of success in advancing environmental sustainability, ironically higher education has received very little attention from academics studying this social (and, of course, natural) phenomenon." The studies conducted at universities, summarized below, cover a variety of environmental behaviors and methods, but few have been aimed at students' consumption behavior in residence halls.

Four studies were based solely on university campuses. Aronson and O'Leary (1983) first used prompts and then modeling to change shower behavior, i.e., turning off water while soaping up, at a university's athletic field house. Prompts were found to be minimally effective, with a 6% – 19% change depending on the size of the sign. But the antecedent strategy of modeling (demonstrating the intended behavior) produced a 49% – 67% decrease in water usage with one and then two models.

Luyben (1980) studied techniques to induce college professors to turn off lights in unused classrooms. Letters initially sent to professors were ineffective, but prompts placed in the classrooms resulted in a 13% increase in lights being turned off. Larson et al. (1995) and Ludwig et al. (1998) used prompts and feedback to successfully increase aluminum can recycling behavior in classroom buildings. In these studies, however, when the strategy promoting the behavior was removed, the behavior returned to pre-study levels.

Two studies were conducted jointly in university and residential settings. Wodarski (1982) reported on four different studies conducted in the late 1970s, three on residential complexes and one on university office buildings. Energy consumption was reduced, however, due to different energy crises that arose during each study, Wodarski could not specifically attribute any reduction in consumption to the techniques he employed. Howard et al. (1993) studied the successful reduction in energy usage by replacing incandescent light bulbs with compact fluorescent bulbs (an efficiency change) in residence halls at Notre Dame University and local residences.

One study did include residence halls. McClelland and Cook (1980) targeted electricity consumption and waste behavior in both classrooms and residence halls. They used a management method, described as using "existing hierarchical lines of communication," and a "user participation" method, wherein groups developed their own conservation plans. Both strategies were successful in reducing electricity consumption and waste behavior. However, the difficulty with this study is evaluating the exact cause in consumption reduction, efficiency versus curtailment changes.

2.8 Gender and ERB

In the plethora of household-scale consumptions studies, notations are made as to the resident composition of the household – male- or female-headed and the presence of children – as well as income and education level. In the limited research at the organizational level, participants' gender is not identified. The key issue is whether gender is important in relation to ERB. Rocheleau et al. (1996) argue that a significant gender-based difference does exist in relation to interactions with the environment. Williams (1994) is more explicit in her argument - because women are nurturing, women are linked to the earth. According to Kollmus and Agyeman (2002), even though women's environmental knowledge is not as thorough as men's, women are more amenable to change their behavior in order to stop environmental destruction.

Many theories exist as to the level of difference in environmental concern. Some researchers, such as Vandana Shiva (1989) (see Rocheleau et al. 1996), make an essentialist argument by asserting the women/nature connection is intrinsic because of women's nurturing propensity (Seager 1993; Williams 1994; Momsen 2000). In contrast, some feminist political ecologists assess the difference as a complex issue arising out of multi-social variables (Seager 1993; Thomas-Slayter et al. 1996; Hawkins and Seager 2010). Although some consumptions studies reviewed for this research raise a possible gender difference, none assess the effect of gender on the successes and failures of promoting ERB in institutional settings.

2.9 Methodology and Statistical Analysis

As outlined in the prior sections, various theories and strategies are used in studies promoting ERB. Surveys or questionnaires have their limitations because they involve participants self-reporting their behavior (Corral-Verdugo and Frías-Armenta 2006; Lawrence and McManus 2008; Millers and Buys 2008; Abrahamse and Steg 2009). Education on the reasons for the intended behavior is integral to promoting initial activity, and prompts placed at the area where the activity should be performed are effective. But, most experts agree that feedback, a consequence strategy, is very important to any change in behavior (Becker 1978; Seligman et al. 1981; Stern and Gardner 1981; Midden et al. 1983; Brandon 1999).

Feedback can take many forms - individual, comparative, or group. However, whichever form is used, all agree that it should be timed sufficiently to reinforce the direct relationship between the actions and the results (Seligman et al. 1981; Midden et al. 1983; Van Raaij and Verhallen 1983). Feedback should also be reported in a form understandable by the study participants (Midden et al. 1983).

Feedback involves a longitudinal analysis of change in consumption levels. Percent increase or decrease is most typically used in studies to calculate changes in ERB. Becker (1978), Midden et al. (1983), Howard et al. (1993), and Schultz et al. (2007) used percentages when showing changes in electricity consumption. Finnie (1973), Cialdini (2003), Larson at el. (1995), and Ludwig et al. (1998) used percentages when calculating change in recycling behavior. Winkler (1982), Geller et al. (1983), Aronson et al. (1983), and Kurz et al. (2005) used percentages when calculating water consumption change.

However, the time period used for baseline data is not uniform in the literature. Different time periods are used in different studies to establish a baseline and, in some cases, multi-variate or multi-regression analysis was required to extrapolate the data to the study period. Seligman and Darley (1977) used a six-week period to establish a baseline. Becker (1978) used a one-month period just immediately prior to his study. Howard et al. (1993), Brandon and Lewis (1999), and Abrahamse and Steg (2009) used one year's prior data. Midden et al. (1983) used only three weeks, Kurz et al. (2005) used only five weeks, and McCalley and Midden (2002) only six trials.

2.10 Summary

Research on ways to promote ERB for conservation of energy and water is available. Although education on conservation of these natural resources clearly falls within the geographic purview, most research and literature on the subject is from disciplines other than geography. Conservation of natural resources is accomplished through use of new technologies (efficiency changes) but resource depletion continues to rise, and most experts agree that to achieve long-term sustainable reductions, repetitive behavior must be changed using curtailment initiatives.

The psychology discipline offers many theories and models on ways to promote ERBs, and many of these theories and models have been used to promote energy conservation in households using curtailment initiatives. Less frequent in the literature are studies promoting water conservation in households using curtailment initiatives. Some literature is available at the organizational/institutional level. However, little research exists on the efforts at universities or colleges despite the fact that many of these institutions are actively involved in conservation and sustainability efforts. Although literature is extensive on the relation between gender differences and the environment, research in curtailment initiatives does not evaluate these differences.

The research processes in the literature concerning the promotion of ERB are not uniform. Many different models exist to explain the barriers and difficulties in promoting ERB, but because social environment affects behavior, no one model is sufficient as a general application. Strategies promoting ERB also vary in the literature. But most experts agree that a combination of strategies appears most effective. Methods for establishing baseline data against which to compare post study data are also not uniform. These methods require in some cases the use of advanced statistical techniques with which to conduct comparisons, such as comparing different times periods of usage, i.e. summer to winter, or comparing different households to each other.

This research will use elements of social norm theory, value-belief norm theory, and the ABC Model to promote ERB relative to water and electricity consumption in on-campus university residence halls. The strategies employed will mirror past research at the household-scale of analysis and analyze success or failure using percent change in consumption during the study period versus historical baseline data. Gender has not been evaluated in the prior household-scale consumption studies. Since the same strategies will be employed in each study group despite the differing gender of the residence halls, evaluation of gender differences relative to water and electricity consumption in this study is possible.

2.11 References

Abrahamse, W., L. Steg, C. Vlek, and T. Rothengatter. 2005. A review of intervention studies aimed at household energy conservation. *Journal of Environmental Psychology* 25(3):273-291.

Abrahamse, W., L. Steg, C. Vlek, and T. Rothengatter. 2007. The effect of tailored information, goal setting, and tailored feedback on household energy use, energy-related behaviors, and behavioral antecedents. *Journal of Environmental Psychology* 27(4):265-276.

Abrahamse, W. and L. Steg. 2009. How do socio-demographic and psychological factors relate to household's direct and indirect energy use and savings? *Journal of Economic Psychology* 30:711-720.

Alabaster, T. and D. Blair. 1996. Greening the university. In *Education for sustainability,* eds. J. Huckle and S. Sterling, 86-104. London: Earthscan Publications, Ltd.

Aronson, E. and M. O'Leary. 1983. The relative effectiveness of models and prompts on energy conservation: A field experiment in a shower room. *Environmental Systems* 12(3):219 – 224.

Barr, S. 2003. Strategies for sustainability: Citizens and responsible environmental behavior. *Area* 35(3):227-240.

Bednarz, R. S. 2006. Environmental research and education in U.S. geography. *Journal of Geography in Higher Education* 30(2):237-250.

Becker, L. J. 1978. Joint effect of feedback and goal setting on performance: A field study of residential energy conservation. *Journal of Applied Psychology* 63(4):428-433.

Brandon, G. and A. Lewis. 1999. Reducing household energy consumption: A qualitative and quantitative field study. *Journal of Environmental Psychology* 19(1):75-85.

Chalkley, B. 2006. Education for sustainable development: Continuation. *Journal of Geography in Higher Education* 30(2):235-236.

Cialdini, R. B. 2003. Crafting normative messages to protect the environment. *Current Directions in Psychological Science* 12(4):105-109.

Corral-Verdugo, V. and M. Frías-Armenta. 2006. Personal normative beliefs, antisocial behavior, and residential water conservation. *Environment and Behavior* 38(3):406-421.

Cutter, S. L., R. Golledge, and W. L. Graf. 2002. The big questions in geography. *The Professional Geographer* 54(3):305-317.

Finnie, W. C. 1973. Field experiments in litter control. *Environment and Behavior* 5(2):123-144.

Geller, E. S. 1989. Applied behavior analysis and social marketing: An integration for environmental preservation. *Journal of Social Issues* 45(1):17-36.

Geller, E. S., J. B. Erickson, and B. A. Buttram. 1983. Attempts to promote residential water conservation with educational, behavioral and engineering strategies. *Population and Environment* 6(2):96-112.

Geller, E.S., J.F. Witmer, and A.L. Orebaugh. 1976. Instructions as a determinant of paper-disposal behaviors. *Environment and Behavior* 8(3):417-438.

Geller, E. S., R. C. Wylie, and J. C. Farris. 1971. An attempt at applying prompting and reinforcement toward pollution control. *Proceedings of the Seventy-Ninth Convention of the American Psychological Association* 6:701-702

Geography Education National Standards Project. 1994. *Geography for life: National geographic standards*. Washington DC: National Geographic Society.

Hansla, A., A. Gamble, A. Juliusson, and T. Gärling. 2008. The relationships between awareness of consequences, environmental concern and value orientations. *Journal of Environmental Psychology* 28:1-9.

Hawkins, R. and J. Seager. 2010. Gender and water in Mongolia. *The Professional Geographer* 62(1):16 – 31.

Higgitt, D. 2006. Finding space for education for sustainable development in the enterprise economy. *Journal of Geography in Higher Education* 30(2):251-262.

Higgitt, D., M. Haigh, and D. Chalkley. 2005. Towards the UN decade of education for sustainable development: Introduction. *Journal of Geography in Higher Education* 29(1):13-17.

Howard, G. S., E. Delgado, D. Miller, and S. Gubbins. 1993. Transforming values into actions: Ecological preservation through energy conservation. *The Counseling Psychologist* 21(4):582-596.

Judkins, G., M. Smith, and E. Keys. 2008. Determinism within human-environment research and the rediscovery of environmental causation. *The Geographic Journal* 174(1):17-29.

Kates, R. W. 1987. The human environment: The road not taken, the road still beckoning. *Annals of the Association of American Geographers* 77(4):525-534.

Kollmus, A. and J. Agyeman. 2002. Mind the gap: Why do people act environmentally and what are the barriers to pro-environmental behavior? *Environmental Education Research* 8(2):239-260.

Kurz, T. 2002. The psychology of environmentally sustainable behavior: Fitting together pieces of the puzzle. *Analyses of Social Issues and Public Policy* 2(1):257-278.

Kurz, T., N. Donaghue, and I. Wakjer. 2005. Utilizing a social-ecological framework to promote water and energy conservation: A field experiment. *Journal of Applied Social Psychology* 35(6):1281-1300.

Larson, M. E., D. Houlihan, and P. N. Goernert. 1995. Brief report: Effects on informational feedback on aluminum can recycling. *Behavioral Interventions* 10(2):111 – 117.

Lawrence, K. and P. McManus. 2008. Towards household sustainability in Sydney? Impacts of two sustainable lifestyle workshop programs on water consumption in existing homes. *Geographical Research* 46(3):314-332.

Lehman, P. K. and E. S. Geller. 2004. Behavior analysis and environmental protection: Accomplishments and potential for more. *Behavior and Social Issues* 13:13-32.

Ludwig, T. D., T. W. Gray, and A. Rowell. 1998. Increasing recycling in academic buildings: A systematic replication. *Journal of Applied Behavior Analysis* 31(4):683-686.

Luyben, P. D. 1980. Effects of informational prompts on energy conservation in college classrooms. *Journal of Applied Behavior Analysis* 13(4):611-617.

Martin, S. and R. Jucker. 2005. Educating earth-literate leaders. *Journal of Geography in Higher Education* 29(1):19-29.

McCalley, L. T. and C. J. H. Midden. 2002. Energy conservation through product-integrated feedback: The roles of goal-setting and social orientation. *Journal of Economic Psychology* 23(5):589-603.

McClelland, L. and S. W. Cook. 1980. Energy conservation in university buildings: Encouraging and evaluating reductions in occupants' electricity use. *Evaluation Review* 4(1):119-132.

McKenzie-Mohr, D. 2000. Fostering sustainable behavior through community-based social marketing. *American Psychologist* 55(5):513-537.

McKenzie-Mohr, D. 2009. Spotlight on social marketing: Fostering sustainable behavior. Plenary Talk at 2009 Behavior, Energy and Climate Change Conference. November 16, 2009. Washington, D.C.

McMakin, A. H., E. L. Malone, and R. E. Lundgren. 2002. Motivating residents to conserve energy without financial incentives. *Environment and Behavior* 34(6):848-863.

Midden, C. J. H., J. F. Meter, M. H. Weenig, and H. J. A. Zieverink. 1983. Using feedback, reinforcement and information to reduce energy consumption in households: A field-experiment. *Journal of Economic Psychology* 3(1):65-86.

Miller, E. and L. Buys. 2008. The impact of social capital on residential water-affecting behaviors in a drought-prone Australian community. *Society and Natural Resources* 21:244-257.

Momsen, J.H. 2000. Gender differences in environmental concern and perception. *Journal of Geography* 99(1):47-56.

National Council for Geographic Education. 2010. Positions Statements. Accessed on March 25, 2010 at http://www.ncge.org/i4a/pages/index.cfm?pageid=3299

Oskamp, S. 2000. Psychological contributions to achieving an ecologically sustainable future for humanity. *Journal of Social Issues* 56(3):373-390.

Palmini, D. J. and T. B. Shelton. 1982. Residential water conservation in a noncrisis setting: Results of a New Jersey Experiment. *Water Resources Research* 18(4):697-704.

Pattison, W. D. 1964. The four traditions of geography. *The Journal of Geography* 63:211-216.

Robinson, J. L. 1976. A new look at the four traditions of geography. *Journal of Geography* 79(9):520-530.

Rocheleau, D., B. Thomas-Slayter, and E. Wangari. 1996. Gender and environment: A feminist political ecology perspective. In *Feminist political ecology: Global issues and local experiences, eds.* D. Rocheleau, B. Thomas-Slayter, and E. Wangari, 3-23. New York: Routledge Publishers.

Rogoff, M. J. 1982. Residential water conservation: A selected research bibliography. *Vance Bibliographies,* P-890. Public Administration Series: Bibliography.

Seager, J. 1993. *Earth Follies: Coming to feminist terms with the global environmental crisis*. New York: Routledge.

Scherbaum, C. A., P. M. Popovich, and S. Finlinson. 2008. Exploring individual-level factors related to employee energy-conservation behaviors at work. *Journal of Applied Social Psychology* 38(3):818-835.

Schultz, P. W. 2000. Empathizing with nature: the effects of perspective taking on concern for environmental issues. *Journal of Social Issues* 56(3):391-406.

Schultz, P. W., J. Nolan, R. B. Cialdini, N. J. Goldstein, and V. Griskevicius. 2007. The constructive, destructive, and reconstructive power of social norms. *Psychological Science* 18(5):429-434.

Seligman, C. and J. M. Darley. 1977. Feedback as a means of decreasing residential energy consumption. *Journal of Applied Psychology* 62(4):363-368.

Seligman, C., L. J. Becker, and J. M. Darley. 1981. Encouraging residential energy conservation through feedback. In *Advances in environmental psychology, Volume 3,* eds. A. Baum and J. E. Singer, 93-113. Hillsdale, NJ: Lawrence Erlbaum Associates.

Starik, M., T. N. Schaeffer, P. Berman, and A. Hazelwood. 2002. Initial environmental project characterizations of four U.S. universities. *Journal of Geography in Higher Education* 3(4):335-345.

Steg, L., L. Dreijerink, and W. Abrahamse. 2006. Why are energy polices acceptable and effective? *Environment and Behavior* 38(1):92-111.

Stern, P. C. 2000. Psychology and the science of human-environment interactions. *American Psychologist* 55(5):523-530.

Stern, P. C. and G. T. Gardner. 1981. Psychological Research and Energy Policy. *American Psychologist* 36(4):329-342.

Stern, P. C., T. Dietz, T. Abel, G. A. Guagnano, and L. Kalof. 1999. A Value-belief-norm theory of support for social movements: The case of environmentalism. *Research in Human Ecology* 6(2):81-97.

Takács-Sánta, A. 2007. Barriers to environmental concern. *Research in Human Ecology* 14(1):26-38.

Taylor, R. G., J. R. McKean, and R. A. Young. 2004. Alternate price specifications for estimating residential water demand. *Land Economics* 80(3):463-475.

Thomas-Slayter, B., E. Wangari, and D. Rocheleau. 1996. Feminist political ecology: Crosscutting themes, theoretical insights, policy implications. In *Feminist political ecology: Global issues and local experiences*, eds. D. Rocheleau, B. Thomas-Slayter, and E. Wangari, 287-307. New York: Routledge Publishers.

Turner, II, B.L. 2002. Contested identities: Human-environment geography and disciplinary implications in a restructuring academy. *Annals of the Association of American Geographers* 92(1):52-74.

U. S. Department of Energy. 2006. Energy demands on water resources. *United States Department of Energy Report to Congress on the Interdependency of Energy and Water.*

Van Raaij, W. F. and T. M. M. Verhallen. 1983. A behavioral model of residential energy use. *Journal of Economic Psychology* 3(1):39-63.

Williams, T. T. 1994. *An unspoken hunger: Stories from the field.* New York: Pantheon Books.

Winkler, R. C. 1982. Water conservation. In *Preserving the environment: New strategies for behavior change*, eds. E. S. Geller, R. A. Winett, and P. B. Everett, 262-287. New York: Pergamon Press.

Wodarski, J. S. 1982. National and state appeals for energy conservation: A behavioral analysis of effects. *Behavioral Engineering* 7(4):119-130.

Yarnal, B. and R. Neff. 2004. Whither parity? The need for a comprehensive curriculum in human-environment geography. *The Professional Geographer* 56(1):28-36.

Chapter 3: Managing water and electricity consumption in university residence halls: A study on promoting voluntary resource conservation by college students

3.1 Abstract

Natural resources are being depleted because of a rising world population and increasing consumption rates. The United Nations advocates that higher education participate in solving the problem of conserving natural resources to sustain the rising population. Sustainability action plans are being implemented on university campuses, but literature on promoting environmentally relevant behavior (ERB) in students residing on university campuses is lacking. On-campus residence halls provide an opportunity for researchers to evaluate strategies promoting ERB and any gender differences in conservation activities. Researchers are examining the promotion of ERB in private households but this research is being accomplished by non-geographers. This paper argues that research on education and conservation of natural resources, and thus promotion of ERB, belongs under the geography purview. This paper reports on a project aimed at promotion of natural resource conservation in a university's residence halls, both female and male occupied. The project employs five different strategies, and in each strategy more stimuli are applied in an effort to produce higher consumption reductions. This paper evaluates the results of the different strategies successes and failures and any observed differences relative to genderERB.

3.2 Key Words:

conservation, natural resources, ERB, university residence halls

3.3 Introduction

Environmental sustainability is a priority of the United Nations. The Agenda 21 report of the U.N. indicates "Special attention should be paid to the demand for natural resources generated by unsustainable consumption and to the efficient use of those resources consistent with the goal of minimizing depletion and reducing pollution" (United Nations 1992). With the world population estimated to reach 9.2 billion people by 2050 (United Nations 2007), the challenge is how to conserve the earth's resources to sustain and meet the needs of the world's rising population. The Agenda 21 report also challenges higher education to assist in finding solutions to this worldwide problem; such participation is advocated by many experts in higher education (Boyer 1990, 1996; Martin and Jucker 2005; Geiser 2006; Albrecht et al. 2007).

In contrast, universities and colleges are instead contributing to the depletion of natural resources. A U.S. Department of Energy study (1993) revealed that buildings at colleges and universities represented 5% (77,000 out of 1,497,000) of total buildings at multi-building facilities in the United States. Yet, despite this low percentage, colleges and universities consume a disproportionately higher 18.6 % (541 trillion BTU out of 2,901 trillion BTU) of the total energy used for all multi-building facilities in the U.S. (U.S. Department of Energy 1993). (Figure 3.1) Twenty percent of those 77,000 university buildings (or 1% of the U.S. total) are residential buildings.

To meet the goal of environmental sustainability set by the U.N. and advocated by others (Boyer 1990, 1996; Martin and Jucker 2005; Geiser 2006; Albrecht et al. 2007), higher education can incorporate environmental issues in curricula, upgrade and change operations, help students understand the causes of environmental issues and injustices (Clugston 2000; Clugston and Calder 2000; Chalkley 2006; Koester et al. 2006), and provide opportunities for students to learn and implement pro-environmental behaviors both in and out of the classroom (Geiser 2006; Kagawa 2007). In the context of these possible initiatives, a key difficulty on the campus is how to promote and implement ERB among students who have decision-making power over their own behavior, but have no financial incentive for conserving resources, and have no input into decisions concerning the efficiency of appliances, building renovations, or university operations.

To illuminate such key issues concerning sustainability on campuses, this research investigates the relationship between different forms of educational media and natural resource consumption on the Virginia Polytechnic Institute and State University's Blacksburg Campus. This study explores whether or not the electricity and water consumption behavior of students living in university residence halls will change in response to various conservation strategies. The strategies included educational media, information, and voluntary resource conservation activities, and were applied at varying levels of intensity across five study groups over two semesters during the 2009 calendar year. Additional questions explored were whether one particular strategy produces higher consumption reductions; whether combining strategies produce more consumption reductions than individual techniques; and whether ERB varies between male and female students.

This paper first discusses the literature in support of the relevance of this research to geography, the literature on promoting ERB in private citizens, and the gap in research on university campuses. Next this paper reviews the study's design, methodology and results. Finally, this paper presents the conclusions reached and identifies additional avenues of investigation.

3.4 Literature

Human-environment interaction is a traditional theme in geography (Association of American Geographers 2010), and the one tradition in which the National Council for Geographic Education specifically references in its position statement on Geo-literacy (National Council for Geographic Education 2010). Environment and Society is one of the Eighteen Standards of Geographical Education and includes human modification of their environment along with humans understanding the importance and usage of natural resources (Geography Education National Standards Project 1994). Because the subject of human-environment interaction is inter-disciplinary, it encompasses anthropogenic social and economic elements along with non-human biological elements; and because geography crosses the boundaries of different disciplines (Turner 2002), the discipline is a natural fit for human-environment research (Kates 1987; Yarnal and Neff 2004).

But does education and research on conservation and sustainability of natural resources belong under the geography umbrella? Judkins et al. (2008) state that research in the human-environment tradition encompasses a diverse range of topics and includes conservation and natural resources. Other experts argue that natural resource sustainability may be a multi-disciplinary issue, but geographers should be the leaders in sustainability education (Higgitt et al. 2005; Martin and Jucker 2005; Bednarz 2006; Chalkley 2006; Higgitt 2006). Professionals in other disciplines also believe that education and research in environmental and sustainability issues belong in the field of geography (Bednarz 2006; Chalkey 2006). Natural resource issues do fall under several of "The Big Questions in Geography" posited by Cutter et al. (2002: 307), such as: "How has the earth been transformed by human action?"; "How do we measure the unmeasurable?"; and "How and why do sustainability and vulnerability change from place to place and over time?".

Yet despite the recognition that conservation and sustainability fall within the geographic purview, a gap exists as few geographers have studied sustainability issues in higher education (Chalkley 2006). Over ten years after Pattison's (1964) identification of the four traditions in geography, experts were recommending an enhanced and more in-depth study of the human-environment dimension (Robinson 1976). When reviewing a list of master's degree theses and Ph.D. dissertations titles in the 2002 Association of American Geographers Guide, Bednarz (2006) noted a lack of graduate student research in sustainability topics. Kates (1987) and Bednarz (2006) noted that if geographers do not take leadership in this area, other professionals will fill this gap in the human-environment tradition. In fact, geographers, such as Barr (2003) and Lawrence and McManus (2008), who studied conservation and sustainability issues in households, reference literature from other social sciences.

Conservation and sustainability relate specifically to human consumption rates, which are behaviors with significant environmental relevance as these rates both directly and indirectly affect natural resources (Brandon and Lewis 1999; McCalley and Midden 2002; Kurz et al. 2005). Consumption rates can be reduced by efficiency changes, which usually relate to one time or infrequent actions and to changes in technology. Efficiency changes produce immediate reductions in consumption of natural resources, and examples would include purchases of alternative fuel vehicles or Energy Star rated appliances, but they do involve an upfront monetary cost. Efficiency changes, along with regulatory requirements, have quite successfully produced decreased natural resource consumption in industries and in many products used by consumers, but most experts agree these will not suffice in addressing environmental issues at an individual level (Stern and Gardner 1981; Van Raaij and Verhallen 1983; Alabaster and Blair 1996; McKenzie-Mohr 2000; Stern 2000; Oskamp 2000; Lehman and Geller 2004; Abrahamse et al. 2005; Steg et al. 2006; Lawrence and McManus 2008).

Consumption rates can also be changed by curtailment initiatives. Curtailment focuses on reducing consumption through changing an individual's repetitive behavior, and experts argue that long-term sustainable reductions are achieved through modification of repetitive behavior (Stern and Gardner 1981; Van Raaij and Verhallen 1983; Geller 1989; McKenzie-Mohr 2000, 2009; Stern 2000; Lehman and Geller 2004; Abrahamse et al. 2005; Steg et al. 2006). But changing ERB is difficult in a society based on high consumption rates (McKenzie-Mohr 2000), because higher incomes may be linked to reduced concern about wasting resources (Seligman et al. 1981; Abrahamse and Steg 2009). Curtailment initiatives include activities such as lowering thermostats in the winter and raising them during the summer or taking shorter showers, and these initiatives have been the focus of many research projects.

The key to encouraging the adoption of ERB is devising strategies to induce change of repetitive behavior. Different theories and models in the literature focus on evaluating strategies to change repetitive behavior.

One perspective, social norm theory, argues that humans are social individuals who are influenced by interactions with other people. Within social norm theory is the idea that humans base their behavior on acceptable and unacceptable behaviors (injunctive norms) and on those behaviors that are most frequently used (descriptive norms). If the unacceptable behavior is the behavior most frequently used, people are most likely to conform to that behavior (Cialdini 2003; Schultz et al. 2007).

Van Raaij and Verhallen (1983), Kurz et al. (2005), and Corral-Verdugo and Frías-Armenta (2006) argue that whether or not people perform ERB is dependent on these social norms. For example, studies on littering examined behavior when an individual was in a clean versus a littered environment, and when the individual saw someone litter or use a trash receptacle. When the environment was littered, more littering occurred. When individuals saw others not littering, littering activities were infrequent (Geller et al. 1971; Finnie 1973; Geller et al. 1976; Cialdini 2003). Social norm theory is applicable to this research because in a university's residence hall, the interactions students have with each other influence their behavior. For instance, if a student sees other students turning off lights when leaving a room, they are likely to also turn off lights when leaving a room.

Influencing one person in a group setting could act as a catalyst to influence group behaviors, and a second perspective, value-belief norm theory, focuses on the individual. Under value-belief norm theory, ERB is prompted when people believe environmental issues threaten their values and they take action to alleviate the threat. This theory identifies three different categories of individual values: 1) egoistic, where people are focused on their own outcomes; 2) altruistic, or concern for others; and 3) biospheric, or ecocentric concern for the non-human environment (Stern et al. 1999; Schultz 2000; Hansla et al. 2008; Scherbaum et al. 2008).

University students exhibit egoistic values because they are focused on attaining a positive outcome from their studies and seek stress relief during their free time. This study intends to adds the foci of altruistic and ecocentric values as students are informed on a) the causes of natural resource depletion, b) the consequences of this depletion, c) the impact of this depletion to their personal life, d) the threat this depletion has on their life, and e) new ways to use natural resources that allow them to maintain their current lifestyle but also to sustain natural resources for the future.

A model widely discussed in the literature that can refocus individual behavior is described by Geller (1989) as the antecedent behavior and consequence model (ABC Model). This model refocuses individuals by providing them with information on the causes of natural resource depletion, on how changing their behavior will lessen their impact on natural resources but not interfere with their lifestyle, and employs techniques to change repetitive behaviors. Antecedent strategies include information and education on reasons for ERB, on the impacts of that behavior on natural resources, and on ways to change that behavior, for example - washing clothes in cold water to reduce energy consumption. A second antecedent strategy is using prompts that outline a specific behavior, for example - stickers on light switches reminding people to turn off the lights as they leave a room. Modeling or demonstrating the intended behavior, for example - a student turning off water while brushing their teeth in a residence hall's common bathroom, is a third antecedent strategy. Commitments or goal setting to the intended behavior -- for example, an agreement to reduce energy use by 10% over prior usage or reducing showering time by two minutes to conserve water and energy -- is a fourth antecedent strategy. Consequence strategies include: feedback on the results of that behavior, for example - reporting to the research participants the resulting decrease or increase in energy usage after the antecedent strategies are in use; and rewards, either positive or negative, to reinforce the behavior, for example - a pizza party for those residence halls that have a positive reduction in energy and water usage.

Researchers apply the antecedent strategies in the early stages of the research. Consequences strategies are techniques that follow antecedent strategies at some point in the research period, and these strategies reinforce the behaviors being promoted. Use of the strategies based on this model can alter individual values because participants realize that acting with ERB allows them to maintain their egoistic values, but can also include concern for others (altruistic) and the environment (ecocentric) with little impact on their lifestyle.

The theories and models relative to changing repetitive behavior are not limited to social norm theory, value-belief norm theory, or the ABC Model, but these are the most pertinent to this research. The theories and models are frequently discussed separately in the literature but, as Kurz (2002) argues, use of one strategy alone will not alter ERB, and she advocates using elements of multiple theories and models. In promoting curtailment initiatives, most experts agree that informing participants on the reasons for the intended behavior is an integral part to promote initial activity, and prompts placed at the area where the activity should be performed help direct the desired behavior, but, feedback is most important in changing behavior (Becker 1978; Seligman et al. 1981; Stern and Gardner 1981; Midden et al. 1983; Chhokar and Wallin 1984; Brandon and Lewis 1999). Feedback can take many forms -- individual, comparative, or group -- and whichever form is used, all agree that it should be timed sufficiently to reinforce the direct relationship between the actions and the results (Seligman et al. 1981; Midden et al. 1983; Van Raaij and Verhallen 1983).

Feedback to study participants involves a longitudinal analysis of consumption levels, a comparison of the usage of the resource being investigated during the study period to usage during some time period in the past. Whether examining energy or water conservation, percent increase or decrease is most typically used in studies calculating changes in ERB, and the results used by Finnie (1973), Becker (1978), Winkler (1982), Aronson and O'Leary (1983), Geller et al. (1983), Midden et al. (1983), Howard et al. (1993), Larson at el. (1995), Ludwig et al. (1998), Cialdini (2003), Kurz et al. (2005), and Schultz et al. (2007). However the time period used for baseline data is not uniform in the literature.

Most case studies focus on household-level behaviors relative to water and energy consumption. The research began with the energy crisis of the 1970s and continues to this date. Household-level energy consumption studies include efficiency changes, but most have focused on curtailment initiatives (Lehman and Geller 2004; Abrahamse et al. 2005) and use of the ABC Model (Abrahamse et al. 2005). Water consumption studies at the household scale, however, focus on efficiency changes, and studies using curtailment strategies are limited (Geller et al. 1983). Some experts opine that water conservation methods using curtailment strategies are ineffective because of the low cost of water and the inability to reduce water bills because of fixed costs (Winkler 1982; Geller et al. 1983; Taylor et al. 2004). Some additionally conclude that, relative to water, the disconnect between behavior and natural resources continues to exist (Corral-Verdugo and Frías-Armenta 2006; Lawrence and McManus 2008; Millers and Buys 2008). Table 3.1 provides a sample of various household-scale consumption studies by author and year, methodology, targeted ERB, and the locale of the research.

While household energy and water consumption studies are numerous, gaps exist in the literature on research aimed at promoting ERB of individuals at the institutional or organizational level (Stern and Gardner 1981; McMakin et al. 2002; Lehman and Geller 2004).

Starik et al. (2002: 336) pointedly state that "while universities and colleges, like other social institutions in the business, government and non-profit sectors, can be said to have had a measure of success in advancing environmental sustainability, ironically higher education has received very little attention from academics studying this social (and, of course, natural) phenomenon." The literature on conservation initiatives conducted at universities is outlined in Table 3.2, and demonstrates the limited nature of the research documented in promoting ERB in university residence halls.

In the plethora of household-scale consumptions studies, notations are made as to the resident composition of the household – male- or female-headed and the presence of children – as well as income and education level. In the limited research at the organizational level, participants' gender is not identified. The key issue is whether gender is important in relation to ERB. Rocheleau et al. (1996) argue that a significant gender-based difference does exist in relation to interactions with the environment. Williams (1994) is more explicit in her argument - because women are nurturing, women are linked to the earth. According to Kollmus and Agyeman (2002), even though women's environmental knowledge is not as thorough as men's, women are more amenable to change their behavior in order to stop environmental destruction.

Many theories exist as to the level of difference in environmental concern. Some researchers, such as Vandana Shiva (1989) (see Rocheleau et al. 1996), make an essentialist argument by asserting that the women/nature connection is intrinsic because of women's nurturing propensity (Seager 1993; Williams 1994; Momsen 2000). In contrast, some feminist political ecologists assess the difference as a complex issue arising out of multi-social variables (Seager 1993; Thomas-Slayter et al. 1996; Hawkins and Seager 2010). Although some consumptions studies raise a possible gender difference, none assess the effect of gender on the successes and failures of promoting ERB in institutional settings.

3.5 Study Site

Virginia Tech is located in the mountains in the western portion of the Commonwealth of Virginia (Figure 3.2). Virginia Tech, established in 1872, was the Commonwealth's first land grant college (Virginia Tech 2009a). Virginia Tech's enrollment in the 2008 school year was 28,259 (Virginia Tech 2009b) with approximately 9,083 students residing in on-campus residence halls (Belcher 2008). Virginia Tech's central campus contains 170 buildings, of which 49 or 29% are residence halls (Virginia Tech 2008). On-campus residence halls are classifield into two groups – dormitories and Greek Houses (fraternities and sororities). The dormitories are distributed in various locations across campus, whereas the Greek Houses are grouped together in the Campus' Oak Lane Community (Figure 3.3).

Virginia Tech's Strategic Plan includes social and environmental changes as part of its social individual transformation goals, along with innovative research in sustainable energy (Virginia Tech 2006). Although Virginia Tech President Charles Steger declined to sign the American College and University President's Climate Commitment, he charged the Energy and Sustainability Committee with developing a Climate Action Commitment by the end of 2008 (Steger 2008). The Committee producing this plan was comprised of staff, professors, and students and held regular meetings throughout the Fall 2008 semester (Cochrane 2008). That the Climate Action Commitment was under development was generally known and eagerly awaited by most students on campus (DeSoto 2008). Yet, promoting ERB among students residing on campus was one of the areas viewed as difficult (Cochrane 2008; Johnson 2008; McClinton 2008), so when this research was proposed to University Administrators in the Fall of 2008, it received wide support.

3.6 Data and Methods

The residence halls were stratified into the two residence hall categories – dormitories and Greek Houses because of differences between the two.   Greek Houses are substantially smaller in size than dormitories, but the square footage occupied per student is higher by at least 20%. Within the Greek Houses, kitchen and bathroom facilities are similar to those found in individual households, whereas those facilities in dormitories resemble hotels or hospitals. In addition, the student population in dormitories changes each school year, but in the Greek Houses the same students reside for most of their university life with only a small percentage changing when students graduate and incoming freshman are initiated into the fraternity or sorority.

After dividing the residence halls into these two strata, variability within each stratum was eliminated using the following building characteristics:

- building design – eliminating any environmentally rated buildings such as LEED or Energy Star,
- renovation and remodeling history – eliminating those with efficiency changes,
- heating and cooling methods – eliminating those halls with air-conditioning as most residence halls are not air-conditioned,
- age – eliminating those meeting recent code requirements, which include efficiency changes,
- kitchen, laundry and bathroom facilities – checking for similarities and differences in composition such as those found in the Greek Houses, and
- structural characteristics including square footage and room composition - calculating percentage of classrooms space and percentage of office space.

After evaluation of building characteristics, to maintain a student population consistent with general campus population, resident demographic information was compared for similarities. Any dormitories with students all belonging to one course of study were eliminated, along with any halls with students belonging to all one class – freshman, sophomore, upper classmen or graduate student. For instance, students in one residence hall belong to an environmental-related major and such would have a greater propensity to ERB without application of any strategies. The twenty residence halls, remaining after variability comparisons, were divided into five different study groups using a random numbers table, each study group containing two dormitories and two Greek Houses.

Different strategies promoting ERB, outlined in detail in Table 3.3, were applied to each of the four halls in each study group, strategies specifically recommended in the ABC Model. Group Number 1 was designated the control group and the students in those residence halls were only informed their residence hall was being included in a study on natural resource conservation. A control group was considered necessary to this research to determine if the final results could be attributed to any influences outside of the strategies employed.

The strategies used in the other four groups were additive in the sense that each subsequent group received all of the techniques of the prior groups and one additional technique. Those in Group 2 (designated “Information Only”) were also advised of their inclusion in the study, and a basic strategy was applied. This basic strategy, via email, provided information explaining how their actions contribute to natural resource depletion, why it was important to understand their contribution to this depletion, and information on ways to reduce their consumption. Included in this information were prompts placed in areas in their residence halls where they could take direct action to change their behavior, such as turning off water while brushing their teeth.

Group 3 (designated “Individual Feedback”) was provided with all the strategies aimed at Group 2, and was also provided with monthly feedback on how their usage during the month compared with their hall's usage during the same month in prior years. Group 4 (designated "Comparative Feedback") received all the same strategies as Group 3 and received information on how their residence halls' results compared with other residence halls in the study. Group 5 (designated "Group Leaders") received all the strategies employed with Group 4, and residents from these four residence halls volunteered to assist with the study – helping to display the informational posters, scheduling informational sessions, and acting as "coaches" to remind other residents in those halls on ways to conserve water and electricity. At the end of each semester, an email invitation was sent out to the students in Groups 2, 3, 4 and 5, asking them to participate in a short survey to self-report their participation in this study.

This study used two calculations in analyzing results: each building's per person per month electricity consumption and each building's per person per month water consumption. Data on seven years of historical water usage (gallons used per residence hall) and four years of historical electricity usage (kilowatt hours used per residence hall) were provided by the University for each of the residence halls within the study.

Population numbers for each residence hall for each of these years was also provided by the University. This information was used to calculate each residence hall's monthly usage per student for the baseline period – January, February, March, April and May for the spring and September, October, November and December for the fall. During the historical data collection process, we learned individual Greek House water usage was not available, so the study focused on electricity conservation in the Greek Houses and electricity and water conservation in the dormitories.

The researcher also determined that heating is accomplished with steam heat and a different system is used to document such consumption. Thus, water consumption in the residence halls was limited to showers, sinks, toilets and water fountains; and the electricity usage in the residence halls was limited to lights and other electrical devices under the control of students. The University continued to provide monthly usage data for each hall throughout both semesters of treatment – Spring and Fall 2009.

Employing the ABC Model's antecedent strategy of information, prompts and posters were placed within the residence halls prior to the commencement of each semester of this study. Students in the study residence halls were advised of their inclusion in the research via email. In the Spring 2009 semester, meetings were held with three volunteers within the two dormitories identified under Group 5 (Team Leaders). Emails were exchanged with the volunteer in one Greek House but no response was received from the volunteer in the 2nd Greek House in Group 5.

During the Fall 2009 semester, no resident agreed to act as a volunteer in any of the residence halls – Greek Houses or dormitories in Group 5. In the Spring semester, educational sessions were held for three of the dormitories but in the Fall 2009 semester, despite repeated invitations, no Greek House nor dormitory participated in an educational session. Periodically throughout both semesters of study, visits were made to all residence halls within the study to replace missing posters and prompts. One dormitory in Group 1 (Control) was excluded from this analysis for the Fall semester due to construction and partial closing. One of the dormitories was a male-occupied building in the Spring semester, but changed to a co-ed occupied building in the Fall semester. In mid-October, with the help of members of the Geographic Society at Virginia Tech, additional educational information and prompts on water usage were placed in the co-ed and female residence halls.

Within two weeks of the start of the Spring semester, the study became contaminated when it became general campus knowledge that conservation research was taking place in the on-campus residence halls. This knowledge did not wane, because throughout both the Spring and Fall semesters, the researcher was repeatedly contacted asking for assistance in promoting conservation in all the residence halls and ways to track their efforts. The researcher was also asked by university administration and student organizations to participate in meetings in an effort to promote conservation after the study concluded.

Throughout the study period, feedback to the residence halls in Group 3 (Individual Feedback), Group 4 (Comparative Feedback), and Group 5 (Group Leaders) was sent to all students each month via email. The feedback provided was the percent change (either increase or decrease) in usage during the month as compared to that month's baseline figure. For water usage, this percentage was the change in gallons used per student as compared to the seven-year historical average. For electricity usage, this percentage was the change in kilowatt hours (kwh) used per student as compared to the four-year historical average.

3.7 Results

Since monthly weather changes were not an influencing factor in this study, the results aggregate data for each semester. Since demographics changed from the spring semester to the fall semester, fall and spring semester data are kept separate. Table 3.4 shows the population figures and gender for each residence hall in this study for each semester.

3.7 a. Water Conservation

Figure 3.4 demonstrates the Spring semester seven-year historical average of water consumption by dormitory in gallons used per student. The monthly historical consumption ranged from 265 gallons per student per month in Dormitory B (a male dormitory) to 872 gallons per student per month in Dormitory E (a female dormitory). Table 3.5 documents the percent change in per student water usage, 2009 Spring semester as compared to the seven-year historical average. The percentage change in water consumption ranges from a decrease of

18.1% in Dormitory K (a male dormitory) to an increase of 17.5% in Dormitory A (co-ed dormitory).

Table 3.6 reflects the percentage change in water consumption, Spring 2009 semester, comparing the dormitories using gender categories. Water consumption decreased in all of the male-occupied dormitories in excess of 10%. The percentage change in water consumption in co-ed dormitories ranges from a decrease of 4.7% to an increase of 17.5%. The percentage change in water consumption in female-occupied dormitories ranged from a decrease of 2.3% to an increase of 12.7%.

The effects of the different types of behavior change strategy for the different study groups (Group 1-Control, Group 2-Information Only, Group 3-Individual Feedback, Group 4-Comparative Feedback, Group 5-Group Leaders) on the percentage change (increase or decrease) of water usage for the Spring 2009 semester were studied by a one-way analysis of variance of a balanced, completely randomized design with two dormitories in each group, for a total of ten dormitories (Table 3.7). At the $\alpha = 0.05$ significance level, there was no statistically significant evidence that percentage change in water consumption varied between the different study groups (Group 1-Control, Group 2-Information Only, Group 3-Individual Feedback, Group 4- Comparative Feedback, Group 5-Group Leaders) ($F = 0.207$, $P = 0.924$) during the Spring 2009 semester.

The effects of gender (male, female, or co-ed) on the percentage change (increase or decrease) in water usage for the Spring 2009 semester were studied by a one-way analysis of variance of a completely randomized design with four male-occupied, three female-occupied, and three co-ed-occupied dormitories, for a total of ten dormitories (Table 3.8). At the $\alpha = 0.05$ significance level, there was statistically significant evidence that percentage change in water consumption varied between the gender categories (male, female, co-ed) ($F = 8.23$, $P = 0.015$)

during the Spring 2009 semester. A multiple comparison of the means accomplished using a Tukey's honest significant difference (HSD) revealed a significant difference between the means of the male dormitories compared to the co-ed and female dormitories, and no significant difference between the means of the co-ed dormitories and the female dormitories (Table 3.9).

Figure 3.5 demonstrates the Fall semester seven-year historical average of water consumption by dormitory in gallons used per student. The monthly historical consumption ranged from 283 gallons per student per month in Dormitory B (a male dormitory) to 1,023 gallons per student per month in Dormitory E (a female dormitory). Table 3.10 documents the percent change in per student water usage, 2009 Fall semester as compared to the seven-year historical average. The percentage change in water consumption ranges from a decrease of 32.6% in Dormitory H (a male dormitory) to an increase of 8.1% in Dormitory K (a male dormitory). Table 3.11 shows the percentage change in water usage among the gender categories; male dormitories and female dormitories had both increases and decreases, whereas all co-ed dormitories achieved decreases.

Table 3.12 reflects the percentage change in water consumption for the months of October, November and December for the female and co-ed dormitories as compared to the seven-year historical average for each of those months. The October 2009 results show water consumption was again increasing over the seven-year historical average, so in late October, additional effort was exerted to increase awareness in these dormitories. The November 2009 results show that water consumption decreased in four of these dormitories and only slightly increased in the other one. The December 2009 results show water consumption decreased by over 20% in all five of these dormitories.

The effects of the different type of behavior change strategy for the different study groups (Group 1-Control, Group 2-Information Only, Group 3-Individual Feedback, Group 4-

Comparative Feedback, Group 5-Group Leaders) on the percentage change (increase or decrease) of water usage for the Fall 2009 semester were studied by a one-way analysis of variance of a completely randomized design with one dormitory in the control group and two dormitories in Groups 2, 3, 4, and 5, for a total of nine dormitories (Table 3.13). At the $\alpha = 0.05$ significance level, there was no statistically significant evidence that percentage change in water consumption varied between the different study groups (Group 1-Control, Group 2-Information Only, Group 3-Individual Feedback, Group 4- Comparative Feedback, Group 5-Group Leaders) ($F = 0.927$, $P = 0.529$) for the Fall 2009 semester.

The effects of gender (male, female, or co-ed) on the percentage change (increase or decrease) of water usage for the Fall 2009 semester were studied by a one-way analysis of variance of a balanced, completely randomized design with three male-occupied, three female-occupied, and three co-ed-occupied dormitories for a total of nine dormitories (Table 3.14). At the $\alpha = 0.05$ significance level, there was not statistically significant evidence that percentage change in water consumption varied between the gender categories (male, co-ed, female) ($F = 1.07$, $P = 0.401$) for the Fall 2009 semester.

3.7 b. Electricity Conservation

Figure 3.6 demonstrates the Spring semester four-year historical average of electricity consumption by residence hall in kilowatt hours per student. The monthly historical consumption ranged from 100 kwh per student per month in Dormitory G to 281 kwh per student per month in Greek House F. Figure 3.7 shows this same information with the residence halls' gender identified. Table 3.15 documents the percent change in electricity usage, 2009 Spring Semester versus historical. With the exception of three Greek Houses (A, B and H), consumption reduction was achieved in all residence halls. The residence hall with the highest per student historical usage, Greek House F, actually achieved the highest percent reduction at 26.5%.

The effects of the different type of behavior change strategy for the different study groups (Group 1-Control, Group 2-Information Only, Group 3-Individual Feedback, Group 4-Comparative Feedback, Group 5-Group Leaders) on the percentage change (increase or decrease) of dormitory electricity usage for the Spring 2009 semester were studied by a one-way analysis of variance of a balanced, randomized complete design with two dormitories in each group, for a total of ten dormitories (Table 3.16). At the $\alpha = 0.05$ significance level, there was no statistically significant evidence that percentage change in dormitory electricity consumption varied between the different study groups (Group 1-Control, Group 2-Information Only, Group 3-Individual Feedback, Group 4- Comparative Feedback, Group 5-Group Leaders) ($F = 3.93$, $P = 0.083$) for the Spring 2009 semester.

The effects of the different type of behavior change strategy for the different study groups (Group 1-Control, Group 2-Information Only, Group 3-Individual Feedback, Group 4-Comparative Feedback, Group 5-Group Leaders) on the percentage change (increase or decrease) of Greek House electricity usage for the Spring 2009 semester were studied by a one-way analysis of variance of a balanced, randomized complete design with two Greek Houses in each group, for a total of ten Greek Houses (Table 3.17). At the $\alpha = 0.05$ significance level, there was statistically significant evidence that percentage change in Greek House electricity consumption varied between the different study groups (Group 1-Control, Group 2-Information Only, Group 3-Individual Feedback, Group 4- Comparative Feedback, Group 5-Group Leaders) ($F = 5.78$, $P = 0.041$) for the Spring 2009 semester.

A multiple comparison of the means accomplished using a Tukey's HSD revealed a significant difference between Group 4-Comparative Feedback and Group 1-Information Only, with Group 4 averaging an 11.2% increase and Group 2 averaging an 18.9% decrease. No significant difference was identified between the means of Group 1-Control, Group 3-Individual Feedback, Group 4-Comparative Feedback, and Group 5-Group Leaders. No significant difference was identified between the means of Group 1-Control, Group 2-Information Only, Group 3-Individual Feedback, and Group 5-Group Leaders. (Table 3.18)

The effects of gender (male, female, or co-ed) on the percentage change (increase or decrease) of electricity usage for the Spring 2009 semester were also studied by a one-way analysis of variance of a completely randomized design with six male-occupied, eleven female-occupied, and three co-ed-occupied residence halls, for a total of twenty residence halls (Table 3.19). At the $\alpha = 0.05$ significance level, there was not statistically significant evidence that percentage change in electricity consumption varied between the gender categories (male, co-ed, female) ($F = 0.752$, $P = 0.486$) for the Spring 2009 semester.

Figure 3.8 demonstrates the Fall semester four-year historical average of electricity consumption by residence hall in kilowatt hours per student. The monthly historical consumption ranged from 124 kwh per student per month in Dormitory G to 307 kwh per student per month in Greek House I. Figure 3.9 shows these same data with the residence halls' gender identified. Table 3.20 documents the percent change in electricity usage, 2009 Fall Semester as compared to the four-year historical average. Consumption reduction was achieved in all halls with the exception of only one Greek House (H). The residence hall with the highest reduction in the Spring, Greek House F, was the same residence hall that achieved the highest reductions in the Fall at 44.2%.

The effects of the different type of behavior change strategy for the different study groups (Group 1-Control, Group 2-Information Only, Group 3-Individual Feedback, Group 4-Comparative Feedback, Group 5-Group Leaders) on the percentage change (increase or decrease) of dormitory electricity usage for the Fall 2009 semester were studied by a one-way analysis of variance of a randomized complete design with one dormitory in Group 1 and two dormitories in each Groups 2, 3, 4 and 5, for a total of nine dormitories (Table 3.21). At the α = 0.05 significance level, there was no statistically significant evidence that percentage change in dormitory electricity consumption varied between the different study groups (Group 1-Control, Group 2-Information Only, Group 3-Individual Feedback, Group 4-Comparative Feedback, Group 5-Group Leaders) (F = 5.79, P = 0.059) for the Fall 2009 semester.

The effects of the different types of behavior change strategy for the different study groups (Group 1-Control, Group 2-Information Only, Group 3-Individual Feedback, Group 4-Comparative Feedback, Group 5-Group Leaders) on the percentage change (increase or decrease) of Greek House electricity usage for the Fall 2009 semester were studied by a one-way analysis of variance of a balanced, randomized complete design with two Greek Houses in each group, for a total of ten Greek Houses (Table 3.22). At the α = 0.05 significance level, there was no statistically significant evidence that percentage change in Greek House electricity consumption varied between the different study groups (Group 1-Control, Group 2-Information Only, Group 3-Individual Feedback, Group 4- Comparative Feedback, Group 5-Group Leaders) (F = 0.577, P = 0.693) for the Fall 2009 semester.

The effects of gender (male, female, or co-ed) on the percentage change (increase or decrease) of electricity for the Fall 2009 semester were studied by a one-way analysis of variance of a completely randomized design with five male-occupied, eleven female-occupied, and three co-ed-occupied residence halls, for a total of nineteen residence halls (Table 3.23). At the α = 0.05 significance level, there was no statistically significant evidence that percentage change in electricity consumption varied between the gender categories (male, female, or co-ed) (F = 0.070, P = 0.933) for the Fall 2009 semester.

3.7 c. End of Semester Surveys

During the last week of April and the first week of December, the students living in the study residence halls were invited to take a short survey to report on their conservation activities. The invitation was sent out to 2,828 students via email. For the Spring Survey, 559 students responded, and 431 students (77%) stated they participated in conservation activities, the most common activity being turning off lights when leaving a room (Table 3.24). Actions in conserving electricity were more frequently used than those for conserving water. No responses were obtained for the Fall Survey, possibly resulting from a glitch in the email invitation sent out by the University.

3.8 Discussion

Except in one instance, the Greek House Spring 2009 electricity results, no statistical significant difference was found between the different strategies promoting ERB. When comparing the means of the Greek House 2009 Group results, the only statistical significant difference was found between Group 4-Comparative Feedback and Group 2-Information Only, with Group 2 achieving the consumption reductions and Group 4 increasing consumption. Since additive strategies did not produce additive reductions in consumption, the results are contrary to Kurz's (2002) argument that more than one strategy is needed to produce results.

As these results show that educational strategies are sufficient, in and of themselves, to alter ERB, they are contrary to the findings of other research analyzing attempts to use educational strategies to alter ERB. For example, in regards to limiting the number of children women bear after having been exposed to family planning programs, research indicates that education about birth control and the consequences of having large families is not sufficient to alter behavior (Mamdani 1972).

The analysis also did not show a statistically significant difference between the three groups receiving feedback (Groups 3, 4, and 5) and Group 2-Information Only. These results again are contrary to the literature, specifically the arguments of Becker (1978), Seligman et al. (1981), Stern and Gardner (1981), Midden et al. (1983), Chhokar and Wallin (1984), and Brandon and Lewis (1999), who opined that feedback is vital to any strategy employed to promote ERB.

When comparing the results of the Spring semester with the results of the Fall semester, the lack of volunteers within Group 5-Group Leaders, the lack of responses to offers of educational sessions and to the Fall end of semester was disconcerting as these showed a lack of interest on the part of the students; however, these do not appear to have impacted the final study results. The most significant difference between the two semesters was the water-use results in the female-occupied dormitories. Reductions were not achieved during the Spring semester, and the success of the Fall semester occurred only after the placement of additional prompts and information posters in late October.

By evidence of the reductions in electricity and water usage in most of the residence halls, students actively conserved resources after merely being provided education on the effects of their consumption, and provided with information on actions to take to reduce their consumption. Appealing individually to the students through the informational emails, posters, and prompts, our request to add altruistic and eco-centric foci to their values resulted in a positive response. That the students created a new social norm of conservation is evidenced by the 77% participation rate in conservation-related activities (as reported by the students in their answers to the Spring end of semester survey) and by the requests from students in those residence halls not included in the study asking if they could be included in the study.

The gender differences in ERB argued by Williams (1994), Rocheleau et al. (1996), Kollmus and Agyeman (2002), and Momsen (2000) are also not supported by this study. In relation to water use, the historical average, the percentage changes during both study periods, and the analysis of variance do not illustrate that female students on Virginia Tech's campus are more amenable than male students to ERB. The analysis of variance for the Spring 2009 period actually shows that male students on Virginia Tech's campus were more amenable to ERB. Regarding electricity use, neither gender showed a higher propensity for ERB. These results may be more demonstrative of the complexity of multi-social variables as argued by Seager (1993), Thomas-Slayter et al. (1996), and Hawkins and Seager (2010).

The results of this study, showing consumption reductions in most residence halls regardless of strategy, could likely be the results of several different factors. First, contamination occurred early in the Spring study period when general campus knowledge of the study occurred, including publication of an article on the study in the local college newspaper. This general knowledge within the resident halls prompted students' requests to this researcher to include their halls in the study or help track their consumption reduction efforts. Second, with the development and then approval of the University's Climate Action Commitment in the spring of 2009, environmental issues were being brought to the attention of the entire University Campus. Finally, since Group 1-Control were notified of their inclusion in the study, consumption reductions could have occurred in those residence halls because of the students' knowledge of that they were being observed and thus actively pursued ERB.

This study has several applications. It can be used as an example in a classroom setting to educate geography students on the relevance of sustainability and natural resources to the human-environment tradition, or a basis for a service-learning geography course in which the students participate in conservation education and learn about the importance of natural resource protection. This research could also be used for students in a sustainability curriculum, showcasing the successes and failures of instilling ERB in individuals, as an example on interdisciplinary and interdepartmental cooperation in a university, or to educate other social science students on strategies to promote ERB. This study can also contribute to the literature on sustainability initiatives on university campuses by reporting on the success of promoting ERB in Virginia Tech's residence halls.

Despite some lack of interest by students during the Fall semester, this research obtained a positive response from the students when promoting ERB. Once students were educated on their impact of consuming natural resources and provided with information on ways to reduce their consumption, student actions changed. Students were able to reduce their consumption by slightly altering their daily activities. In addition, achievement in consumption reductions occurred even in the control groups because of students' desires to participate in conservation-related activities once general knowledge of the activities was known across campus.

This study could assist Virginia Tech officials in developing the best strategies to induce students living on campus to conserve water and electricity, which will ultimately result in University cost savings and reducing its carbon footprint. Reports to the University were provided at the end of each study period. At the beginning of the second study period, the Office of Residence Life held meetings to determine the best way to continue promoting ERB after the end of the study. As a result, a residence hall competition in conservation, Eco-Olympics, was scheduled for the Spring 2010.

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3.10 References

Abrahamse, W., L. Steg, C. Vlek, and T. Rothengatter. 2005. A review of intervention studies aimed at household energy conservation. *Journal of Environmental Psychology* 25(3):273-291.

Abrahamse, W., L. Steg, C. Vlek, and T. Rothengatter. 2007. The effect of tailored information, goal setting, and tailored feedback on household energy use, energy-related behaviors, and behavioral antecedents. *Journal of Environmental Psychology* 27(4):265-276.

Abrahamse, W. and L. Steg. 2009. How do socio-demographic and psychological factors relate to household's direct and indirect energy use and savings? *Journal of Economic Psychology* 30:711-720.

Alabaster, T. and D. Blair. 1996. Greening the university. In *Education for sustainability,* eds. J. Huckle and S.Sterling, 86-104. London: Earthscan Publications, Ltd.

Albrecht, P., S. Burandt, and S. Schaltegger. 2007. Do sustainability projects stimulate organizational learning in universities? *International Journal of Sustainability in Higher Education* 8(4):403-415.

Aronson, E. and M. O'Leary. 1983. The relative effectiveness of models and prompts on energy conservation: A field experiment in a shower room. *Environmental Systems* 12(3):219 – 224.

Association of American Geographers. 2010. Accessed on March 25, 2010 at https://communicate.aag.org/eseries/scriptcontent/custom/giwis/cguide/explore_field.cfm

Barr, S. 2003. Strategies for sustainability: Citizens and responsible environmental behavior. *Area* 35(3):227-240.

Bednarz, R. S. 2006. Environmental research and education in U.S. geography. *Journal of Geography in Higher Education* 30(2):237-250.

Becker, L. J. 1978. Joint effect of feedback and goal setting on performance: A field study of residential energy conservation. *Journal of Applied Psychology* 63(4):428-433.

Belcher, K. 2008. Associate Director of Occupancy Management - Virginia Polytechnic Institute and State University. October 15, 2008.

Boyer, E. L. 1990. *Scholarship reconsidered: Priorities of the professoriate*. Princeton, NJ: The Carnegie Foundation for the Advancement of Teaching.

Boyer, E. L. 1996. The scholarship of engagement. *Journal of Public Service and Outreach* 1(1):11-20.

Brandon, G. and A. Lewis. 1999. Reducing household energy consumption: A qualitative and quantitative field study. *Journal of Environmental Psychology* 19(1):75-85.

Chalkley, B. 2006. Education for sustainable development: continuation. *Journal of Geography in Higher Education* 30(2):235-236.

Chhokar, J. S. and J. A. Wallin. 1984. A field study of the effect of feedback frequency on performance. *Journal of Applied Psychology* 69(3):524-530.

Cialdini, R. B. 2003. Crafting normative messages to protect the environment. *Current Directions in Psychological Science* 12(4):105-109.

Clugston, R. M. 2000. Introduction. In *Sustainability and university life, 2nd revised edition*, ed. W. L. Filho, 11-18. New York: Peter Lang Publishing.

Clugston, R. M. and W. Calder. 2000. Critical dimensions of sustainability in higher education. I n *Sustainability and university life, 2nd revised edition*, ed. W. L. Filho, 31-46. New York: Peter Lang Publishing.

Cochrane, D. C. 2008. Energy and Sustainability Coordinator – Virginia Polytechnic Institute and State University Office of the Associate Vice President of Facilities. Interviewed on September 12, 2008 at Blacksburg, Virginia.

Commonwealth of Virginia. 2002. GIS Data. Accessed November 25, 2009 at http://gisdata.virginia.gov/Portal/

Corral-Verdugo, V. and M. Frías-Armenta. 2006. Personal normative beliefs, antisocial behavior, and residential water conservation. *Environment and Behavior* 38(3):406-421.

Cutter, S. L., R. Golledge, and W.L. Graf. 2002. The big questions in geography. *The Professional Geographer* 54(3): 305-317.

DeSoto, Angelia. 2008. Executive Board Member - Environmental Coalition, Founding Member - Coalition for Campus Sustainability, Coordinator – VT Green Team and Sustainability Planning Intern - Energy and Sustainability Committee to develop the Virginia Polytechnic Institute and State University Climate Action Commitment. Interviewed on September 12, 2008 at Blacksburg, Virginia.

Finnie, W. C. 1973. Field experiments in litter control. *Environment and Behavior* 5(2):123-144.

Geller, E. S. 1989. Applied behavior analysis and social marketing: An integration for environmental preservation. *Journal of Social Issues* 45(1):17-36.

Geller, E. S., J. B. Erickson, and B. A. Buttram. 1983. Attempts to promote residential water conservation with educational, behavioral and engineering strategies. *Population and Environment* 6(2):96-112.

Geller, E.S., J.F. Witmer, and A.L. Orebaugh. 1976. Instructions as a determinant of paper-disposal behaviors. *Environment and Behavior* 8(3):417-438.

Geller, E. S., R. C. Wylie, and J. C. Farris. 1971. An attempt at applying prompting and reinforcement toward pollution control. *Proceedings of the Seventy-Ninth Convention of the American Psychological Association* 6:701-702

Geiser, K. 2006. Education for a transition to sustainability. In *Inside and out: Universities and education for sustainable development,* eds. R.Forrant and L. Silka, 29-40. Amityville, NY: Baywood Publishing.

Geography Education National Standards Project. 1994. *Geography for life: National geographic standards*. Washington DC: National Geographic Society.

Gonzales, M. H., E. Aronson, and M. A. Constanzo. 1988. Using social cognition and persuasion to promote energy conservation: A quasi-experiment. *Journal of Applied Social Psychology* 18 (12):1049-1066.

Hansla, A., A. G., A. Juliusson, and T. Gärling. 2008. The relationships between awareness of consequences, environmental concern and value orientations. *Journal of Environmental Psychology* 28:1 – 9.

Hawkins, R. and J. Seager. 2010. Gender and water in Mongolia. *The Professional Geographer* 62(1):16-31.

Higgitt, D. 2006. Finding space for education for sustainable development in the enterprise economy. *Journal of Geography in Higher Education* 30(2):251-262.

Higgitt, D., M. Haigh, and D. Chalkley. 2005. Towards the UN decade of education for sustainable development: Introduction. *Journal of Geography in Higher Education* 29(1):13-17.

Howard, G. S., E. Delgado, D. Miller, and S. Gubbins. 1993. Transforming values into actions: Ecological preservation through energy conservation. *The Counseling Psychologist* 21(4):582-596.

Johnson, R. 2008. Director of Housing and Dining Services. Virginia Polytechnic Institute and State University. Interviewed on September 26, 2008 at Blacksburg, Virginia.

Judkins, G., M. Smith, and E. Keys. 2008. Determinism within human-environment research and the rediscovery of environmental causation. *The Geographic Journal* 174(1):17-29.

Kates, R. W. 1987. The human environment: The road not taken, the road still beckoning. *Annals of the Association of American Geographers* 77(4):525-534.

Kawaga, F. 2007. Dissonance in students' perceptions of sustainable development and sustainability: Implications for curriculum change. *International Journal of Sustainability in Higher Education* 8(3):317-338.

Koester, R., J. Eflin, and J. Vann. 2006. Beyond disciplines: Integrating academia, operations and community for campuswide education for sustainability. In *Inside and out: Universities and education for sustainable development*, eds. R. Forrant and L. Silka, 41-61. Amityville, NY: Baywood Publishing.

Kollmus, A. and J. Agyeman. 2002. Mind the gap: Why do people act environmentally and what are the barriers to pro-environmental behavior? *Environmental Education Research* 8(2):239-260.

Kurz, T. 2002. The psychology of environmentally sustainable behavior: Fitting together pieces of the puzzle. *Analyses of Social Issues and Public Policy* 2(1):257-278.

Kurz, T., N. Donaghue, and I. Wakjer. 2005. Utilizing a social-ecological framework to promote water and energy conservation: A field experiment. *Journal of Applied Social Psychology* 35(6):1281-1300.

Larson, M. E., D. Houlihan, and P. N. Goernert. 1995. Brief report: Effects on informational feedback on aluminum can recycling. *Behavioral Interventions* 10(2):111 – 117.

Lawrence, K. and P. McManus. 2008. Towards household sustainability in Sydney? Impacts of two sustainable lifestyle workshop programs on water consumption in existing homes. *Geographical Research* 46(3):314-332

Lehman, P. K. and E. S. Geller. 2004. Behavior analysis and environmental protection: Accomplishments and potential for more. *Behavior and Social Issues* 13:13-32.

Ludwig, T. D., T. W. Gray, and A. Rowell. 1998. Increasing recycling in academic buildings: A systematic replication. *Journal of Applied Behavior Analysis* 31(4):683-686.

Luyben, P. D. 1980. Effects of informational prompts on energy conservation in college classrooms. *Journal of Applied Behavior Analysis* 13(4):611-617.

Mamdani, M. 1972. *The myth of population control: Family, caste, and class in an Indian village.* New York: Monthly Review Press.

Martin, S. and R. Jucker. 2005. Educating earth-literate leaders. *Journal of Geography in Higher Education* 29(1):19-29.

McCalley, L. T. and C. J. H. Midden. 2002. Energy conservation through product-integrated feedback: The roles of goal-setting and social orientation. *Journal of Economic Psychology* 23(5):589-603.

McClelland, L. and S. W. Cook. 1980. Energy conservation in university buildings: Encouraging and evaluating reductions in occupants' electricity use. *Evaluation Review* 4(1):119-132.

McClinton, L. 2008. Director of Residence Life. Virginia Polytechnic Institute and State University. Interviewed on September 26, 2008 at Blacksburg, Virginia.

McKenzie-Mohr, D. 2000. Fostering sustainable behavior through community-based social marketing. *American Psychologist* 55(5):513-537.

McKenzie-Mohr, D. 2009. Spotlight on social marketing: Fostering sustainable behavior. Plenary Talk at 2009 Behavior, Energy and Climate Change Conference. November 16, 2009. Washington, D.C.

McMakin, A. H., E. L. Malone, and R. E. Lundgren. 2002. Motivating residents to conserve energy without financial incentives. *Environment and Behavior* 34(6):848-863.

Midden, C. J. H., J. F. Meter, M. H. Weenig, and H. J.A. Zieverink. 1983. Using feedback, reinforcement and information to reduce energy consumption in households: A field-experiment. *Journal of Economic Psychology* 3(1):65-86.

Miller, E. and L. Buys. 2008. The impact of social capital on residential water-affecting behaviors in a drought-prone Australian community. *Society and Natural Resources* 21:244-257.

Momsen, J.H. 2000. Gender differences in environmental concern and perception. *Journal of Geography* 99(1):47-56.

National Council for Geographic Education. 2010. Position Statements. Accessed on March 25, 2010 at http://www.ncge.org/i4a/pages/index.cfm?pageid=3299

Oskamp, S. 2000. Psychological contributions to achieving an ecologically sustainable future for humanity. *Journal of Social Issues* 56 (3):373 – 390.

Palmini, D. J. and T. B. Shelton. 1982. Residential water conservation in a noncrisis setting: Results of a New Jersey experiment. *Water Resources Research* 18(4):697-704.

Pattison, W. D. 1964. The four traditions of geography. *The Journal of Geography* 63:211-216.

Robinson, J. L. 1976. A new look at the four traditions of geography. *Journal of Geography* 79(9): 520-530.

Rocheleau, D., B. Thomas-Slayter, and E. Wangari. 1996. Gender and environment: A feminist political ecology perspective. In *Feminist political ecology: Global issues and local experiences*, eds. D. Rocheleau, B. Thomas-Slayter, and E. Wangari, 3-23. New York: Routledge Publishers.

Sall, J., A. Lehman, and L. Creighton. 2001. *JMP start statistic: A guide to statistics and data analysis using JMP® and JMP IN® Software, 2nd Edition*. Pacific Grove, CA: Duxbury.

Scherbaum, C. A., P. M. Popovich, and S. Finlinson. 2008. Exploring individual-level factors related to employee energy-conservation behaviors at work. *Journal of Applied Social Psychology* 38(3):818-835.

Schultz, P. W. 2000. Empathizing with nature: The effects of perspective taking on concern for environmental issues. *Journal of Social Issues* 56(3):391-406.

Schultz, P. W., J. Nolan, R. B. Cialdini, N. J. Goldstein, and V. Griskevicius. 2007. The constructive, destructive, and reconstructive power of social norms. *Psychological Science* 18(5):429 – 434.

Seager, J. 1993. *Earth Follies: Coming to feminist terms with the global environmental crisis.* New York*:* Routledge.

Seger, C. 2008. President of Virginia Polytechnic Institute and State University. Letter to Members of the Environmental Coalition dated April 23, 2008.

Seligman, C. and J. M. Darley. 1977. Feedback as a means of decreasing residential energy consumption. *Journal of Applied Psychology* 62(4):363-368.

Seligman, C., L. J. Becker, and J. M. Darley. 1981. Encouraging residential energy conservation through feedback. In *Advances in Environmental Psychology, Volume 3,* eds. A. Baum and J. E. Singer, 93-113. Hillsdale, NJ: Lawrence Erlbaum Associates.

Starik, M., T. N. Schaeffer, P. Berman, and A. Hazelwood. 2002. Initial environmental project characterizations of four U.S. universities. *Journal of Geography in Higher Education* 3(4):335-345.

Steg, L, L. Dreijerink, and W. Abrahamse. 2006. Why are energy polices acceptable and effective? *Environment and Behavior* 38(1):92-111.

Stern, P. C. 2000. Psychology and the science of human-environment interactions. *American Psychologist* 55(5):523-530.

Stern, P. C. and G. T. Gardner. 1981. Psychological Research and Energy Policy. *American Psychologist* 36(4):329-342.

Stern, P. C., T. Dietz, T. Abel, G. A. Guagnano, and L. Kalof. 1999. A Value-belief-norm theory of support for social movements: The case of environmentalism. *Research in Human Ecology* 6(2):81 – 97.

Taylor, R. G., J. R. McKean, and R. A. Young. 2004. Alternate price specifications for estimating residential water demand. *Land Economics* 80(3):463-475.

Thomas-Slayter, B., E. Wangari, and D. Rocheleau. 1996. Feminist political ecology: Crosscutting themes, theoretical insights, policy implications. In *Feminist political ecology: Global issues and local experiences,* eds. D. Rocheleau, B. Thomas-Slayter, and E. Wangari, 287-307. New York: Routledge Publishers.

Turner, II, B.L. 2002. Contested identities: Human-environment geography and disciplinary implications in a restructuring academy. *Annals of the Association of American Geographers* 92(1):52-74.

United Nations. 1992. Department of Economic and Social Affairs, Division of Sustainable Development. *Agenda 21*. Last updated 15 December 2004. Accessed on August 17, 2008 at http://www.un.org/esa/sustdev/documents/agenda21/

United Nations. 2007. Department of Economic and Social Affairs, Population Division. *World population prospects: The 2006 revision, highlights*. Accessed on August 17, 2008 at http://ww.un.org/esa/population/publications/wpp2006/WPP2006_Highlights_rev.pdf

U. S. Department of Energy. 1993. Assessment of Energy Use in Multi-building Facilities. Accessed on August 23, 2008 at http://www.eia.doe.gov/emeu/cbecs/archive/arch_hist_pubs/cbecs_pdf/DOE%20EIA-0555(93)-1.pdf

Van Raaij, W. F. and T. M. M. Verhallen. 1983. A behavioral model of residential energy use. *Journal of Economic Psychology* 3(1):39-63.

Virginia Tech. 2006. Virginia Polytechnic Institute and State University Mission Statement and Strategic Plan. Last updated 2006. Accessed on August 23, 2008 at www.vt.edu.

Virginia Tech 2008. GIS Layers provided by Virginia Tech Facilities Information System.

Virginia Tech. 2009a. Accessed on February 13, 2010 at http://spec.lib.vt.edu/archives/125th/timeline.htm

Virginia Tech. 2009b. Historical enrollment figures. Accessed on November 26, 2009 at http://spec.lib.vt.edu/archives/databook/text/chap2/2_2.htm

Williams, T. T. 1994. *An unspoken hunger: Stories from the field.* New York*:* Pantheon Books.

Winkler, R. C. 1982. Water conservation. In *Preserving the environment: New strategies for behavior change,* eds. E. S. Geller, R. A. Winett, and P. B. Everett, 262-287. New York: Pergamon Press.

Wodarski, J. S. 1982. National and state appeals for energy conservation: A behavioral analysis of effects. *Behavioral Engineering* 7(4):119-130.

Yarnal, B. and R. Neff. 2004. Whither parity? The need for a comprehensive curriculum in human-environment geography. *The Professional Geographer* 56(1):28-36.

Zar, J.H. 2010. *Biostatistical Analysis, 5th Edition.* Upper Saddle River, NJ: Prentice Hall.

3.11 Figures

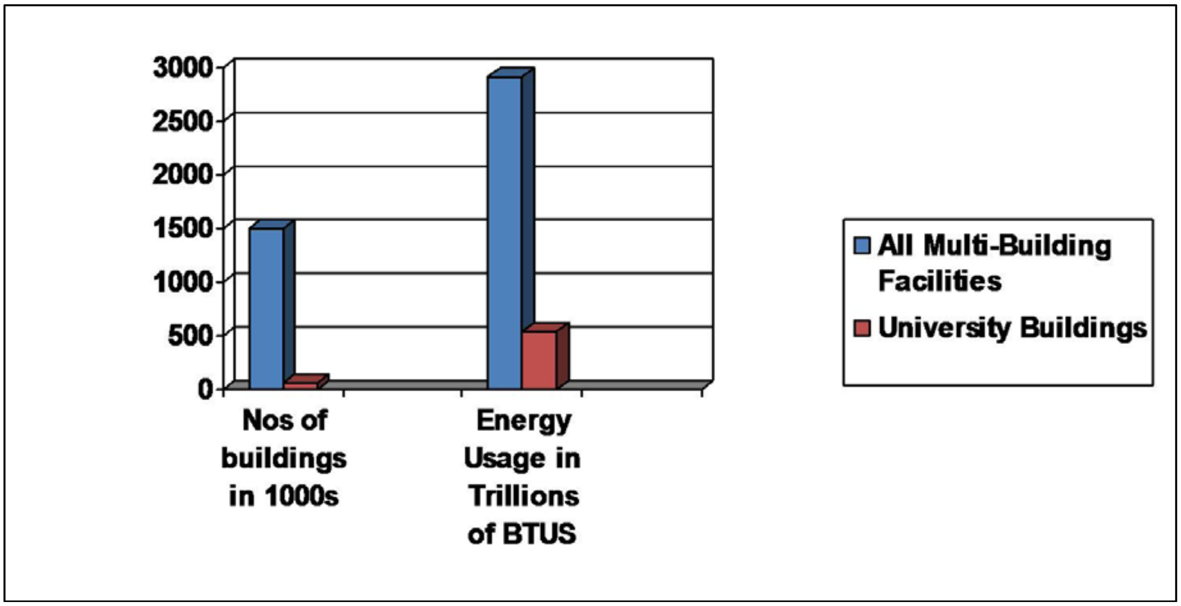


Figure 3.1 Energy Usage in Multi-Building Facilities
(Data Source: U.S. Department of Energy 1993)

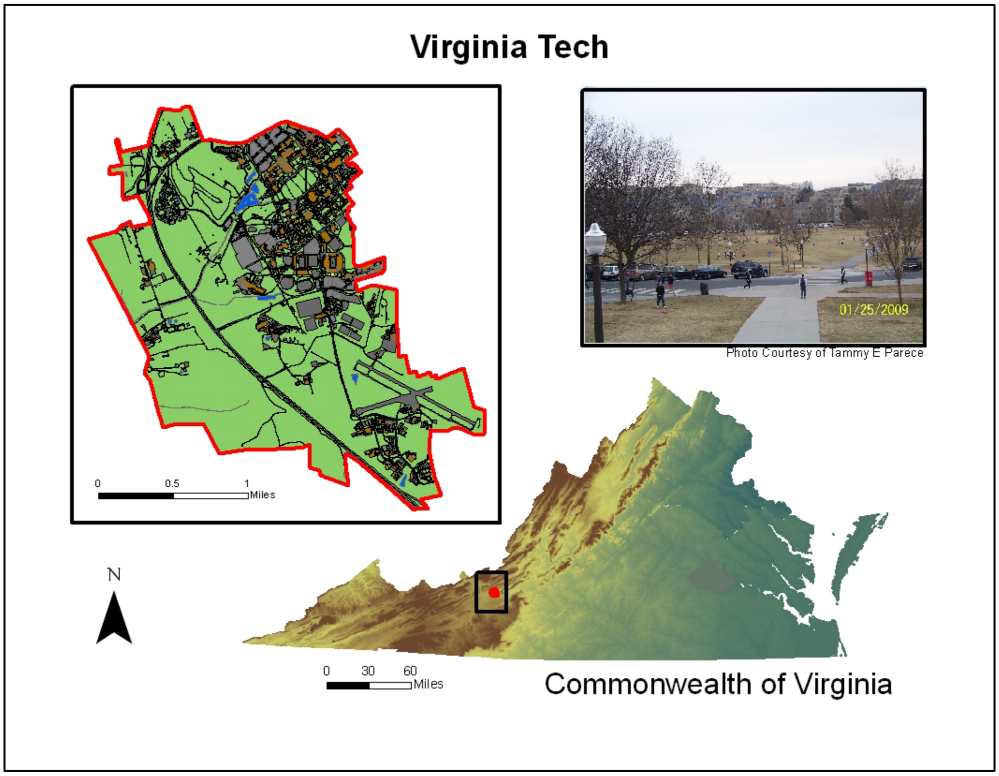


Figure 3.2 Virginia Tech Reference Map
(Data Sources: Commonwealth of Virginia GIS 2002; Author 2008; Virginia Tech 2008)

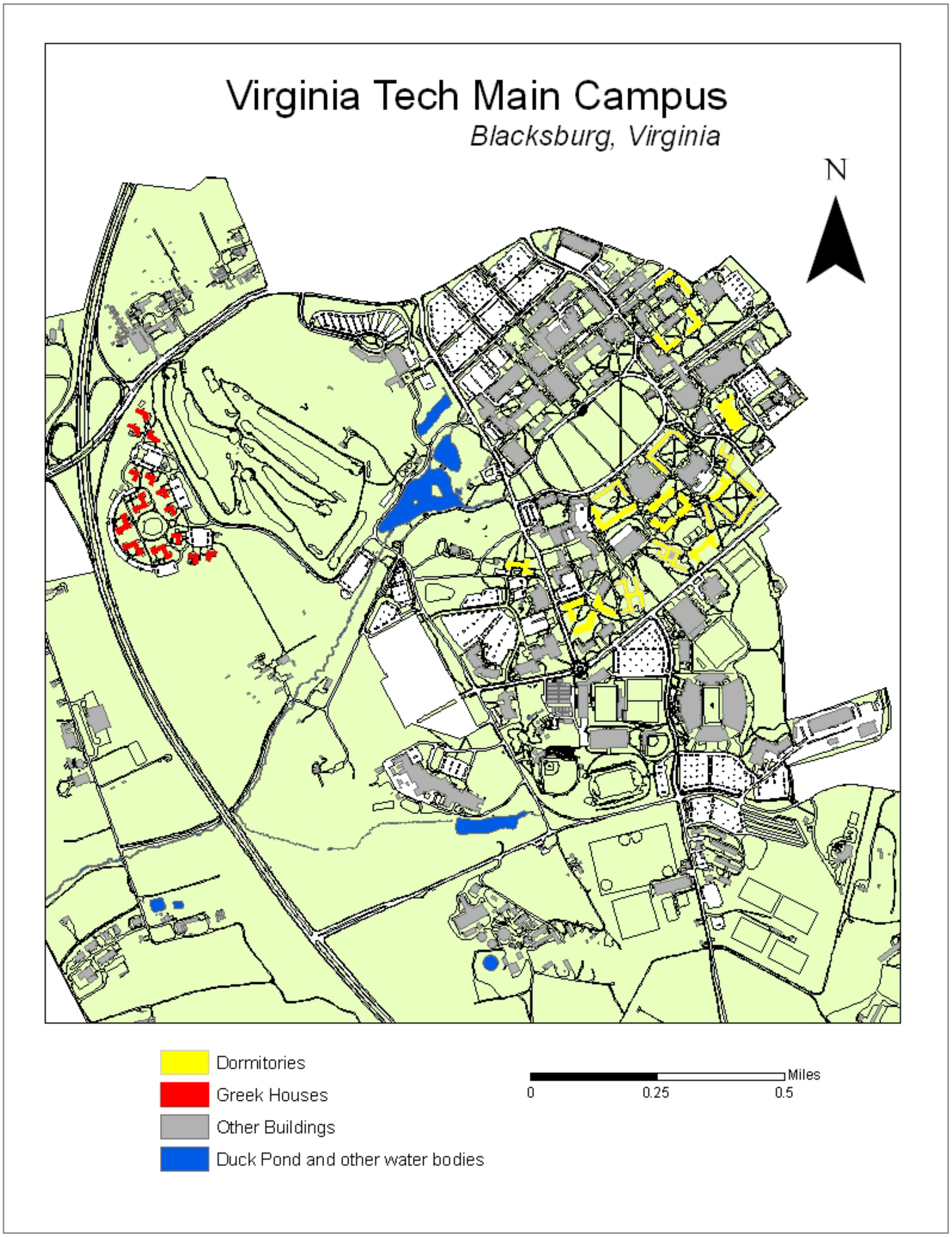


Figure 3.3 Locations of On-Campus Residence Halls
(Data Source: Virginia Tech 2008)

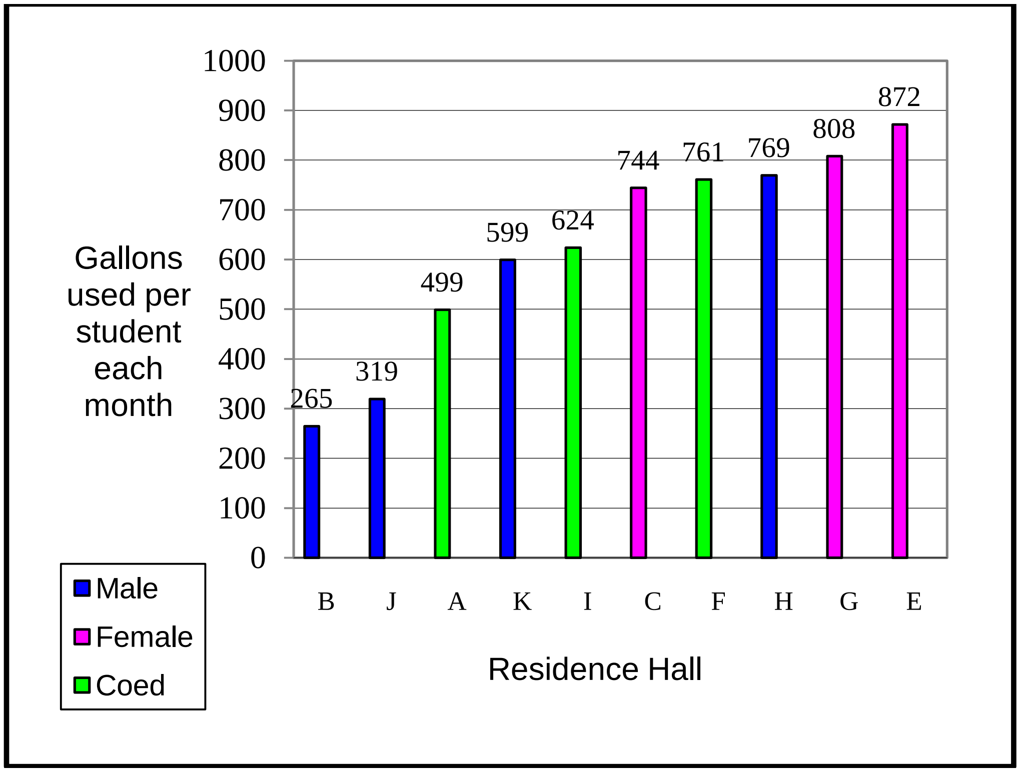


Figure 3.4 Spring Historical Water Usage – Seven Year Average (2002 – 2008)

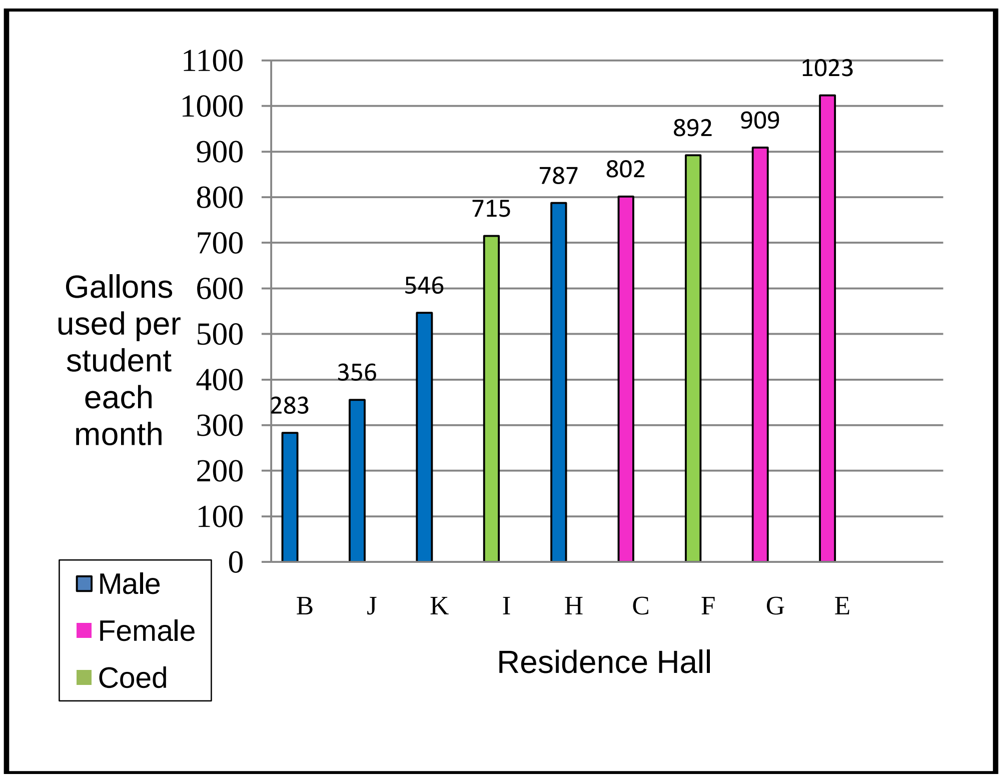


Figure 3.5 Fall Historical Water Usage – Seven Year Average (2002 – 2008)

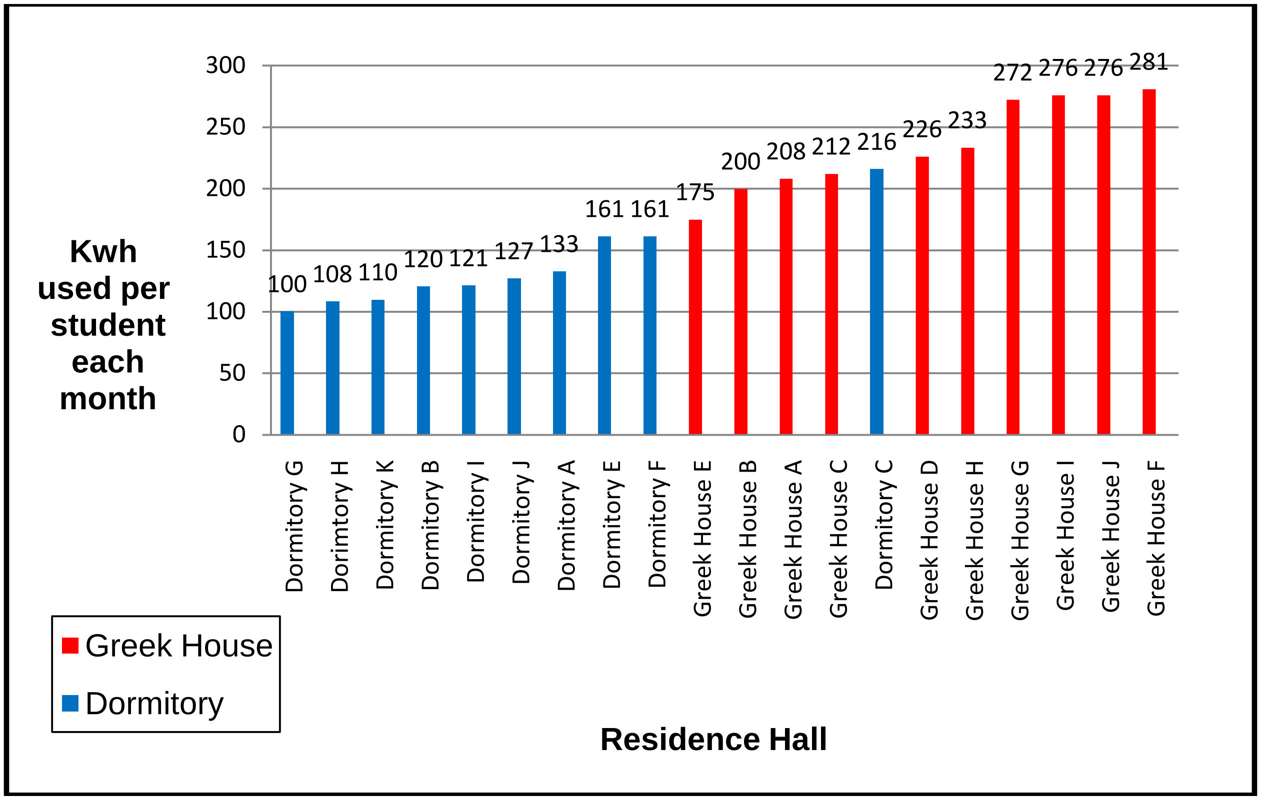


Figure 3.6 Spring Historical Electricity Usage – Four Year Average (2005 – 2008)

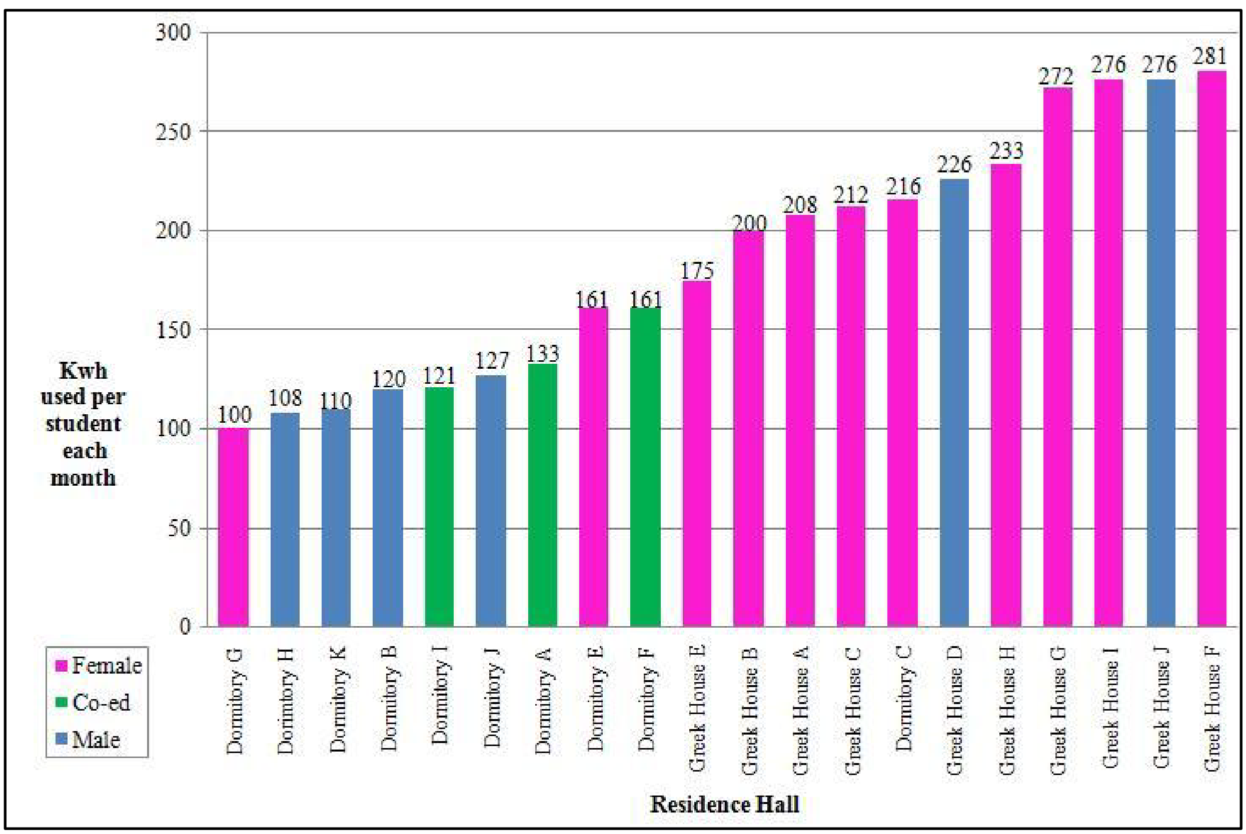


Figure 3.7 Spring Historical Electricity Use, Gender – Four Year Average (2005 – 2008)

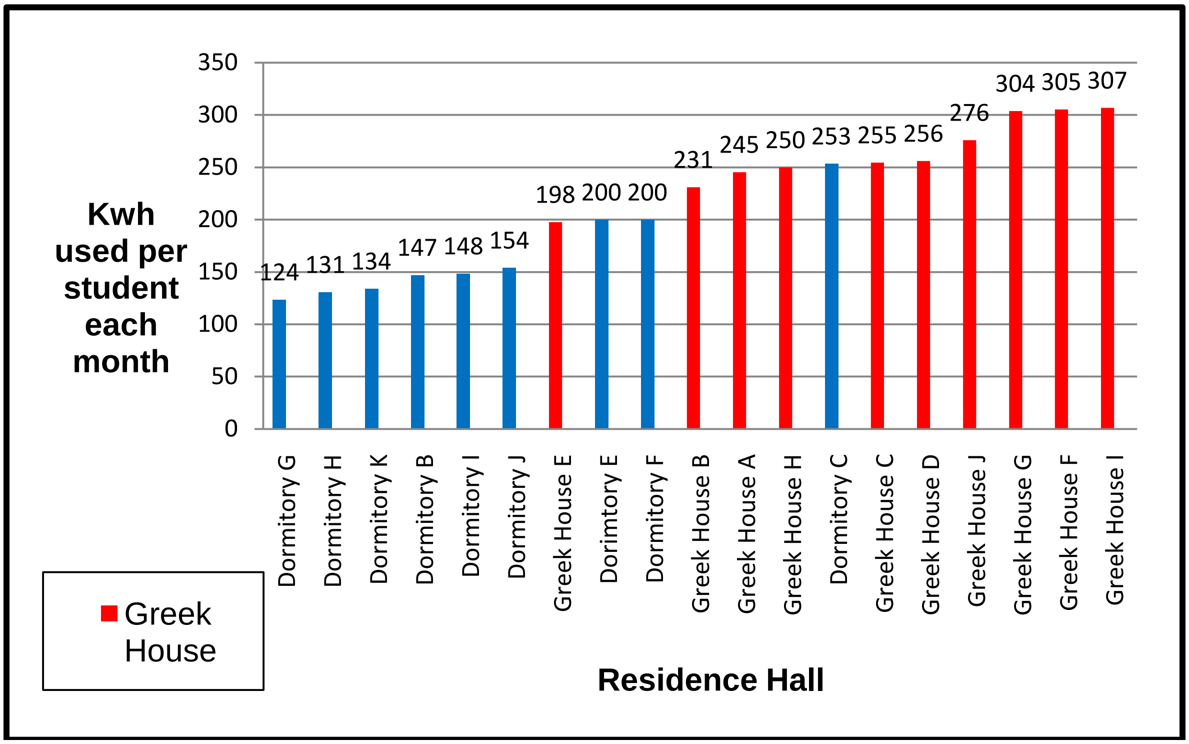


Figure 3.8 Fall Historical Electricity Usage – Four Year Average (2005 – 2008)

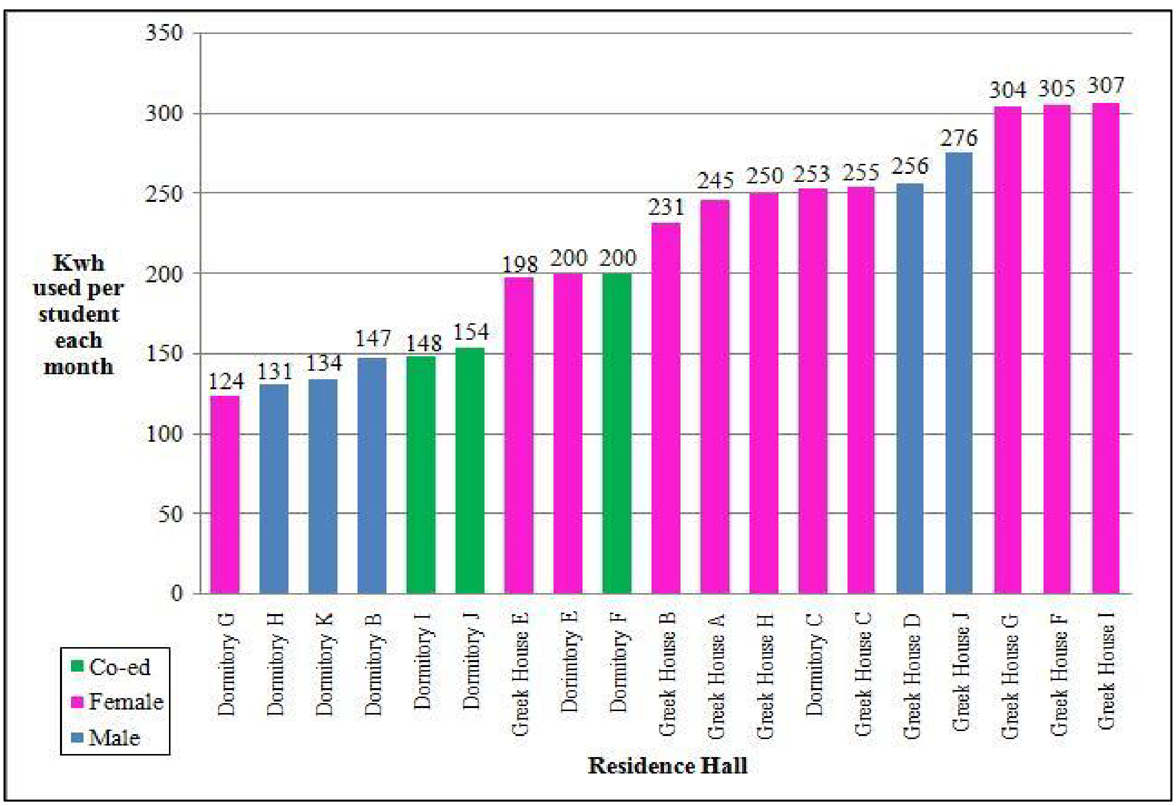


Figure 3.9 Fall Historical Electricity Use, Gender – Four Year Average (2005 – 2008)

3.12 Tables

Table 3.1 A Selection of Household-Level Consumption Research

Author (Year)	Methodology	Targeted Behavior	Locale
Finnie (1973)	Prompts	Littering	Richmond, VA; Philadelphia, PA & St. Louis, MO
Seligman & Darley (1977)	Feedback	Energy consumption	Central New Jersey
Becker (1978)	Feedback and goal setting	Energy conservation	Central New Jersey
Palmini and Shelton (1982)	Efficiency Changes*	Water Conservation	East Brunswick Township, NJ
Geller et al. (1983)	Efficiency*, Education & Feedback	Water Conservation	Blacksburg, VA
Midden et al. (1983)	Education, Feedback & monetary rewards	Energy conservation	Voorschoten, Netherlands
Gonzales et al. (1988)	Interviews	Evaluation of the effectiveness of a home energy audit program	California
Howard et al. (1993)	Efficiency Changes*	Electricity conservation	South Bend/Mishawaka/Granger, IN
Brandon and Lewis (1999)	Feedback	Energy Conservation	Bath, U.K.
McMakin et al. (2002)	Focus groups, interviews, Education, activities	Energy conservation	Residences on military bases – Yuma, AZ and Fort Lewis
McCalley and Midden (2002)	Feedback and Goal setting	Energy and water consumption	Eindhoven, Netherlands
Kurz et al. (2005)	Information and Feedback	Water and energy consumption	Perth, Austrialia
Abrahamse et al. (2007)	Questionnaires, Information, Feedback	Energy consumption	Groningen, Netherlands
Miller and Buys (2008)	Survey	Water conservation	Queensland, Australia
Lawrence and McManus (2008)	Interviews and questionnaires	Water consumption	Sydney, Australia

*Efficiency changes refer to changes in technology and appliances, such as hybrid vehicles and water and electricity saving devices

Table 3.2 Studies in University Settings

Author (Year)	Methodology	Targeted Behavior	Locale
Aronson and O'Leary (1983)	Prompts and modeling	Water – showering	University field house
McClelland and Cook (1980)	Efficiency* and self development	Electricity	Classrooms and dormitories
Luyben (1980)	Information and then prompts	Electricity	Classrooms
Wodarski (1982)	Efficiency Changes*	Electricity	Office buildings and non-university residential
Howard et al. (1983)	Efficiency Changes*	Electricity	Residence halls and non-university residential
Larson et al. (1995)	Prompts and feedback	Recycling	Classrooms
Ludwig et al. (1998)	Prompts and feedback	Recycling	Classrooms

*Efficiency changes refer to changes in technology and appliances, such as hybrid vehicles and water and electricity saving devices

Table 3.3 Study groups and strategies

	Group 1 – Control	Group 2 - Information Only	Group 3 – Feedback	Group 4- Comparative Feedback	Group 5 – Team Leaders
Dormitories n = 10	2	2	2	2	2
Greek Houses n = 10	2	2	2	2	2
Antecedent Strategies used	Initial email advising of study	Initial email	Initial email	Initial email	Initial email
		Educational information	Educational information	Educational information	Educational information
		Prompts	Prompts	Prompts	Prompts
		Posters	Posters	Posters	Posters
		Periodic follow up emails providing educational information	Periodic follow up emails providing educational information	Periodic follow up emails providing educational information	Periodic follow up emails providing educational information
Consequence Strategies used	None	None	Monthly feedback on their residence hall's results	Monthly feedback on their residence hall's results	Monthly feedback to team leaders on their residence hall's results
				Monthly Feedback on how their residence hall's results compares to others halls in the study	Leaders within the halls to act as a coach to remind students of techniques to reduce consumption

Table 3.4 Student Population Numbers for Residence Halls (Belcher 2008)

Residence Hall (Group Number*)	Population Spring 2009	Gender Spring 2009	Population Fall 2009	Gender Fall 2009
Dormitory A (1)	1,315	Co-ed	426	Co-ed
Dormitory B (1)	219	Male	217	Male
Dormitory C (5)	165	Female	164	Female
Dormitory E (3)	215	Female	215	Female
Dormitory F (3)	201	Co-ed	199	Co-ed
Dormitory G (2)	179	Female	179	Female
Dormitory H (4)	217	Male	218	Male
Dormitory I (4)	345	Co-ed	339	Co-ed
Dormitory J (5)	1,026	Male	1,016	Co-ed
Dormitory K (2)	329	Male	325	Male
Greek House A (1)	23	Female	28	Female
Greek House B (4)	25	Female	29	Female
Greek House C (3)	29	Female	33	Female
Greek House D (5)	30	Male	29	Male
Greek House E (2)	34	Female	31	Female
Greek House F (2)	26	Female	26	Female
Greek House G (3)	29	Female	28	Female
Greek House H (4)	28	Female	27	Female
Greek House I (5)	25	Female	28	Female
Greek House J (1)	22	Male	25	Male

*Group Number 1- Control: only notified of their inclusion in the study

Group Number 2 – Information Only: provided with education materials on the causes of resource depletion and activities to take to conserve water and electricity

Group Number 3 – Individual Feedback: received the same strategies as Group Number 2 and also monthly information on the percentage change in their residence halls' consumption

Group Number 4 – Comparative Feedback: received the same strategies as Group Numbers 2 and 3, and also monthly information on the percentage change in their residence hall's consumption as compared to other residence halls in the study

Group Number 5 – Group Leaders: received the same strategies as Group Numbers 2, 3, and 4, and volunteers within their residence halls acted as coaches in their daily conservation activities

Table 3.5 Percent change in per student water use, Spring 2009 versus historical average

Group 1 (Control)	Group 2 (Information Only)	Group 3 (Individual Feedback)	Group 4 (Comparative Feedback)	Group 5 (Team Leaders)
Dorm A	Dorm G	Dorm E	Dorm I	Dorm C
+17.5%	+6.3%	-2.3%	-4.7%	+12.7%
Dorm B	Dorm K	Dorm F	Dorm H	Dorm J
-11.2%	-18.1%	+0.7%	-14.5%	-15.9%

Table 3.6 Percent change in per student water use by gender, Spring 2009 versus historical average

Male Occupied	Co-ed Occupied	Female Occupied
Dorm B	Dorm A	Dorm E
-11.2%	+17.5%	-2.3%
Dorm K	Dorm F	Dorm C
-18.1%	+0.7%	+12.7%
Dorm H	Dorm I	Dorm G
-14.5%	-4.7%	+6.3%
Dorm J		
-15.9%		

Table 3.7 Analysis of Variance by Group – Percent change in water use, Spring 2009

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	R^2
Treatment Type*	4	0.019	0.005	0.207	0.924	14.2
Error	5	0.117	0.0234			
C. Total	9	0.136				

* Group 1 (Control), Group 2 (Information Only), Group 3 (Individual Feedback), Group 4 (Comparative Feedback), Group 5 (Group Leaders)

Table 3.8 Analysis of Variance by Gender – Percent change in water use, Spring 2009

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	R^2
Gender*	2	0.096	0.048	8.23	0.015	70.2
Error	7	0.041	0.006			
C. Total	9	0.136				

*****male, co-ed, female

Table 3.9 Mean Percent change by gender in water use, Spring 2009

Gender*	Mean	SE
Female	0.056[A]	0.067
Co-ed	0.050[A]	0.044
Male	-0.15[B]	0.015

*Levels not connected by same letter are significantly different.
α= 0.05 level experiment wise using Tukey's HSD (Sall et al. 2001; Zar 2010)

Table 3.10 Percent change in per student water use, Fall 2009 versus historical average

Group 1 (Control)	Group 2 (Information Only)	Group 3 (Individual Feedback)	Group 4 (Comparative Feedback)	Group 5 (Team Leaders)
Dorm A	Dorm G	Dorm E	Dorm I	Dorm C
Excluded	-3.8%	+2.8%	-11.7%	+0.5%
Dorm B	Dorm K	Dorm F	Dorm H	Dorm J
-10.2%	+8.1%	-6.8%	-32.6%	-30.9%

Table 3.11 Percent change in per student water use by gender, Fall Semester 2009

Male Occupied	Co-ed Occupied	Female Occupied
Dorm B	Dorm F	Dorm E
-10.2%	-6.8%	+2.8%
Dorm K	Dorm I	Dorm C
+8.1%	-11.7%	+0.5%
Dorm H	Dorm J	Dorm G
-32.6%	-30.9%	-3.8%

Table 3.12 Monthly percent change in water use, Co-ed and Female Occupied Dormitories

	October	November	December
Dorm F (co-ed)	+13.5%	-20.3%	-34.4%
Dorm G (female)	+55.3%	-5.6%	-28.1%
Dorm E (female)	+30.6%	+3.3%	-26.8%
Dorm I (co-ed)	+10.8%	-21.4%	-40.6%
Dorm C (female)	+36.3%	-8.3%	-26.5%

Table 3.13 Analysis of Variance by Group – Percent change in water use, Fall 2009

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	R^2
Treatment Type*	4	0.077	0.019	0.927	0.529	48.1
Error	4	0.083	0.021			
C. Total	8	0.160				

* Group 1 (Control), Group 2 (Information Only), Group 3 (Individual Feedback), Group 4 (Comparative Feedback), Group 5 (Group Leaders)

Table 3.14 Analysis of Variance by Gender – Percent change in water use, Fall 2009

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	R^2
Gender*	2	0.042	0.021	1.07	0.401	26.2
Error	6	0.118	0.020			
C. Total	8	0.160				

*male, co-ed, female

Table 3.15 Percent change in per student electricity use, Spring 2009 versus historical average

Group 1 (Control)	Group 2 (Information Only)	Group 3 (Individual Feedback)	Group 4 (Comparative Feedback)	Group 5 (Team Leaders)
Dorm A	Dorm G	Dorm E	Dorm I	Dorm C
-14.7%	-2.5%	-9.5%	-11.2%	-9.1%
Dorm B	Dorm K	Dorm F	Dorm H	Dorm J
-13.0%	-9.1%	-9.5%	-11.9%	-8.0%
Greek House J	Greek House E	Greek House C	Greek House B	Greek House D
-5.4%	-11.4%	-11.7%	+16.6%	-11.9%
Greek House A	Greek House F	Greek House G	Greek House H	Greek House I
+3.2%	-26.5%	-12.8%	+5.8%	-5.4%

Table 3.16 Dormitory Analysis of Variance – by Group – Percent change in electricity use, Spring 2009

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	R^2
Treatment Type*	4	0.0077	0.002	3.93	0.083	75.9%
Error	5	0.002	0.0004			
C. Total	9	0.010				

* Group 1 (Control), Group 2 (Information Only), Group 3 (Individual Feedback), Group 4 (Comparative Feedback), Group 5 (Group Leaders)

Table 3.17 Greek House Analysis of Variance – by Group – Percent change in electricity use, Spring 2009

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	R^2
Treatment Type*	4	0.106	0.027	5.78	0.041	82.2%
Error	5	0.023	0.004			
C. Total	9	0.130				

* Group 1 (Control), Group 2 (Information Only), Group 3 (Individual Feedback), Group 4 (Comparative Feedback), Group 5 (Group Leaders)

Table 3.18 Greek House Mean Percent Change in Electricity by Group – Spring 2009

Group*	Mean	SE
4 (Comparative Feedback)	+11.2%[A]	0.054
1 (Control)	-1.1%[AB]	0.043
5 (Group Leader)	-8.7%[AB]	0.033
3 (Individual Feedback)	-12.2%[AB]	0.005
2 (Information Only)	-18.9%[B]	0.075

*Levels not connected by same letter are significantly different.
α= 0.05 level experiment wise using Tukey's HSD (Sall et al. 2001; Zar 2010)

Table 3.19 Analysis of Variance – by Gender - percent change in electricity use Spring 2009

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	R^2
Gender*	2	0.012	0.006	0.752	0.486	8.1%
Error	17	0.135	0.008			
C. Total	19	0.147				

***male, co-ed, female**

Table 3.20 Percent change in per student electricity use, Fall 2009 versus historical average

Group 1 (Control)	Group 2 (Information Only)	Group 3 (Individual Feedback)	Group 4 (Comparative Feedback)	Group 5 (Team Leaders)
Dorm A	Dorm G	Dorm E	Dorm I	Dorm C
Excluded	-13.7%	-22.1%	-18.2%	-14.7%
Dorm B	Dorm K	Dorm F	Dorm H	Dorm J
-14.6%	-15.8%	-22.1%	-13.4%	-15.0%
Greek House J	Greek House E	Greek House C	Greek House B	Greek House D
-21.8%	-8.4%	-19.2%	-18.3%	-12.9%
Greek House A	Greek House F	Greek House G	Greek House H	Greek House I
-19.0%	-44.2%	-14.2%	+8.5%	-21.8%

Table 3.21 Dormitory Analysis of Variance – by Group – Percent change in electricity use, Fall 2009

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	R^2
Treatment Type*	4	0.0078	0.0019	5.79	0.059	85.3%
Error	4	0.0013	0.0003			
C. Total	8	0.009				

* Group 1 (Control), Group 2 (Information Only), Group 3 (Individual Feedback), Group 4 (Comparative Feedback), Group 5 (Group Leaders)

Table 3.22 Greek House Analysis of Variance – by Group – Percent change in electricity use, Fall 2009

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	R^2
Treatment Type*	4	0.049	0.012	0.577	0.693	31.6%
Error	5	0.106	0.021			
C. Total	9	0.155				

* Group 1 (Control), Group 2 (Information Only), Group 3 (Individual Feedback), Group 4 (Comparative Feedback), Group 5 (Group Leaders)

Table 3.23 Analysis of Variance – by Gender – Percent change in electricity use, Fall 2009

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	R^2
Gender*	2	0.001	0.001	0.070	0.933	0.8%
Error	16	0.162	0.010			
C. Total	18	0.164				

*male, co-ed, female

Table 3.24 Spring 2009 Survey Results

Question	Answer	Number of Responses	Percent
Were you aware that your residence hall was participating in a study on conserving water and electricity?	yes	528	94.6
	no	30	5.4
How did you find out about the study? Check all that apply	received an email	479	85.7
	saw the notices posted in my residence hall	288	51.5
	attended a seminar held in my residence hall	8	1.4
	did not know about the study	19	3.4
Did you actively participate in this study?	yes	431	77.1
	no	126	22.9
If you answered yes to question 3, please indicate which of the following actions you took? (check all that apply)	turned off lights in unoccupied rooms	420	97.4
	turned off my computer when not in use	202	46.9
	turned off all power strips when not in use	40	9.3
	used task lights when available and not overhead lighting	207	48.0
	only washed full loads of laundry	387	89.8
	did not overload clothes dryers	240	55.9
	washed clothes in cold water	156	36.2
	turned off the water while brushing my teeth	379	88.0
	turned off water while shaving.	184	42.3
	took a shorter shower	142	32.9
	took a shower instead of a bath	154	35.7
	reported any water leaks or running toilets immediately to maintenance	44	10.2
	turned off all electronics when gone for the weekend	241	55.9
	turned off all electronics when gone for spring-break	391	90.1
	took no action	30	5.4
Will you continue your conservation related activities	yes	503	90.0
	no	55	9.8

when you leave the residence hall and move off-campus?			
If you are in a university residence hall during the Fall 2009 Semester, will you participate in conservation activities	yes	348	62.3*
	no	112	20.0*

*Figures do not total 100% because some students responding to the survey did not answer this question. **(Source: Fieldwork)**

Appendix A – Posters and Prompts

Figure A.1 – Shower Hanger purchased from Banner Ideas

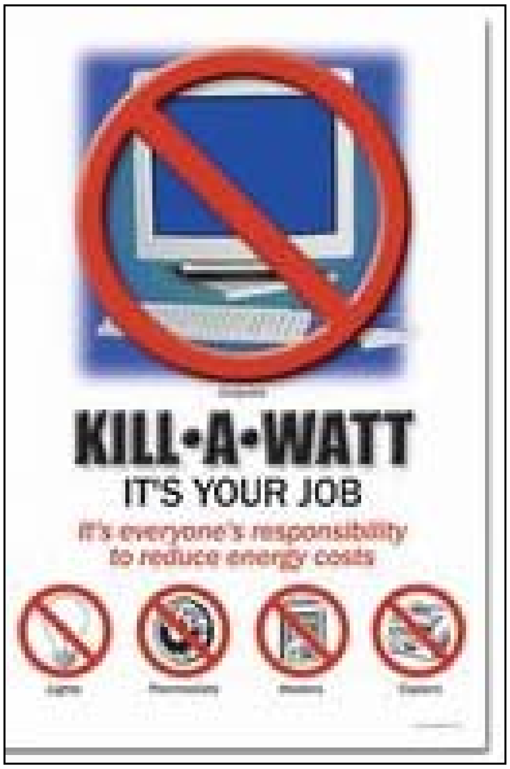


Figure A.2 – Poster purchased from Banner Ideas

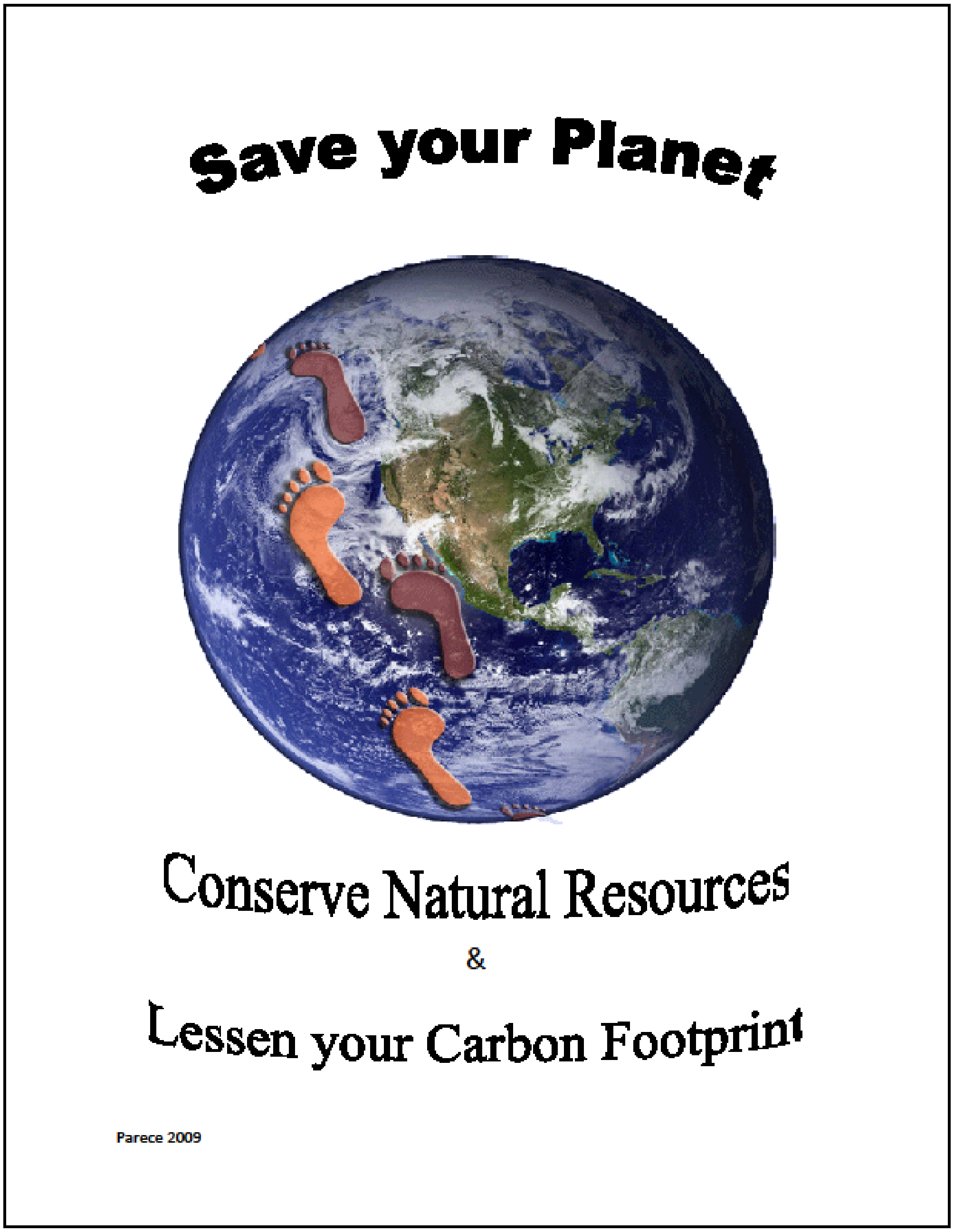


Figure A.3 Conservation Poster placed on bulletin boards
Source: Designed by author with Microsoft® ClipArt*

Figure A.4 Electricity Conservation Poster placed in laundry rooms
Source: Designed by author with Microsoft® ClipArt*

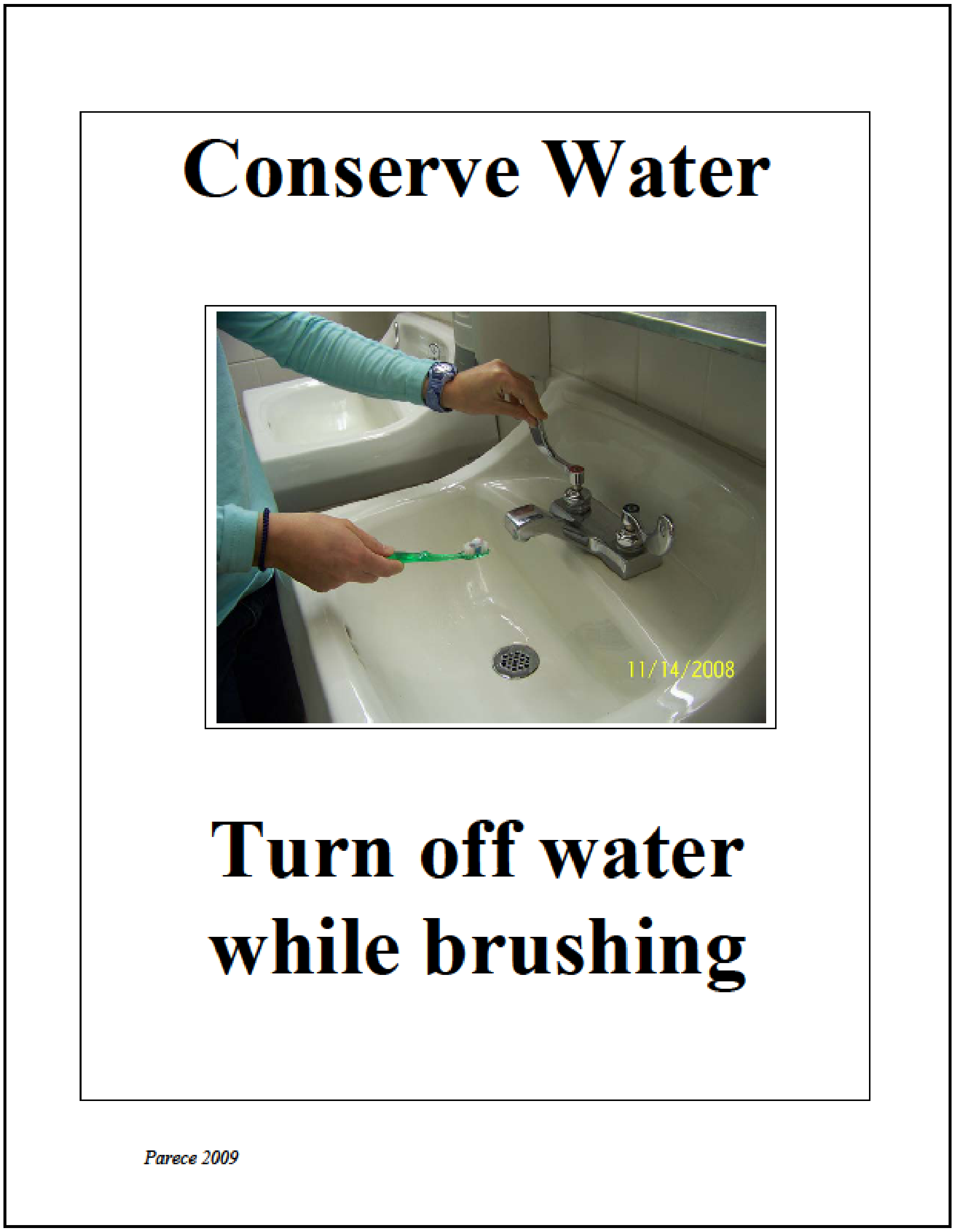


Figure A.5 Water Conservation Poster placed in bathrooms
Source: Designed by author; Photo by author

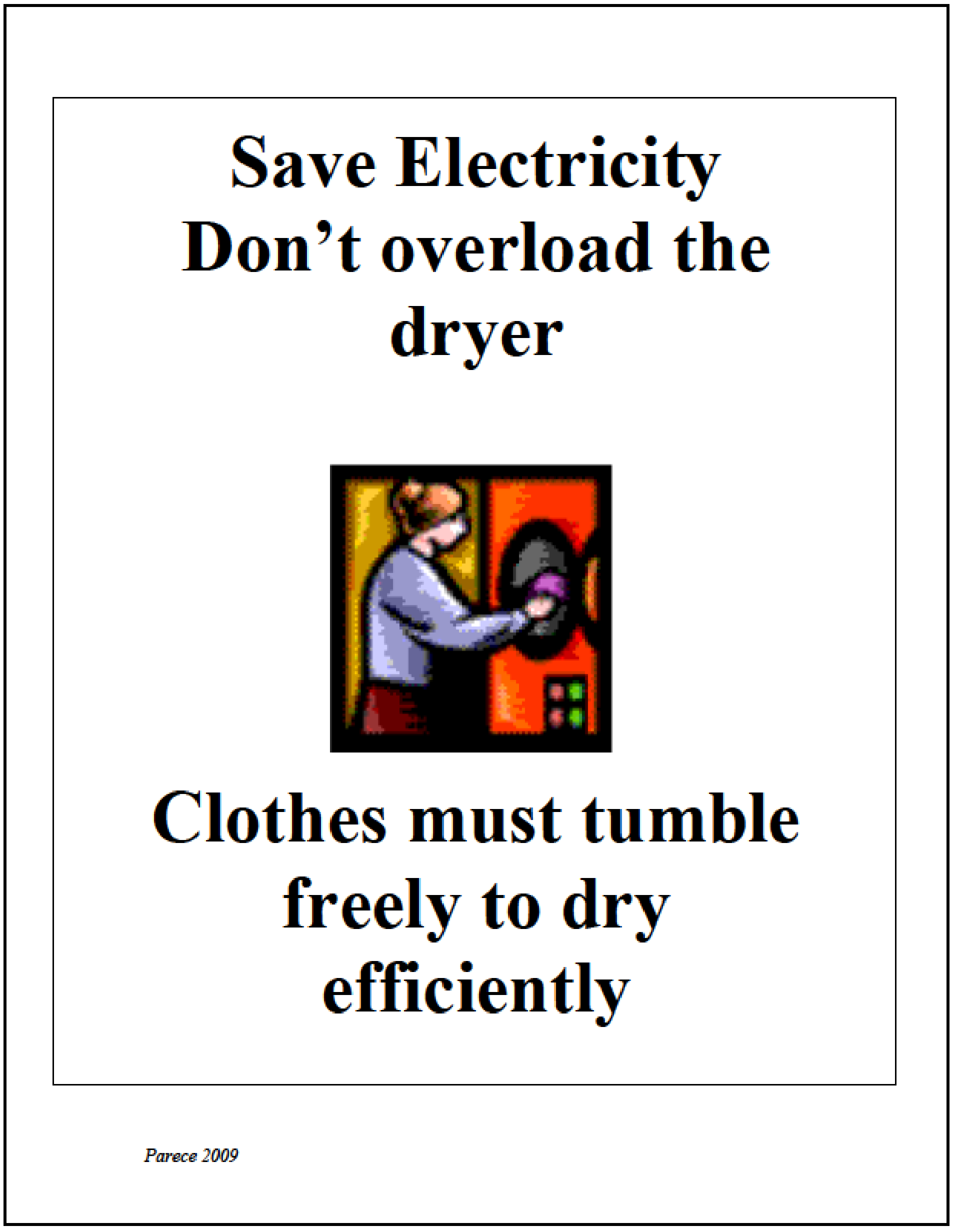


Figure A.6 Electricity Conservation Poster placed in laundry rooms
Source: Designed by author with Microsoft® ClipArt*

Figure A.7 Electricity Conservation Poster placed on bulletin boards
Source: Designed by author with Microsoft® ClipArt*

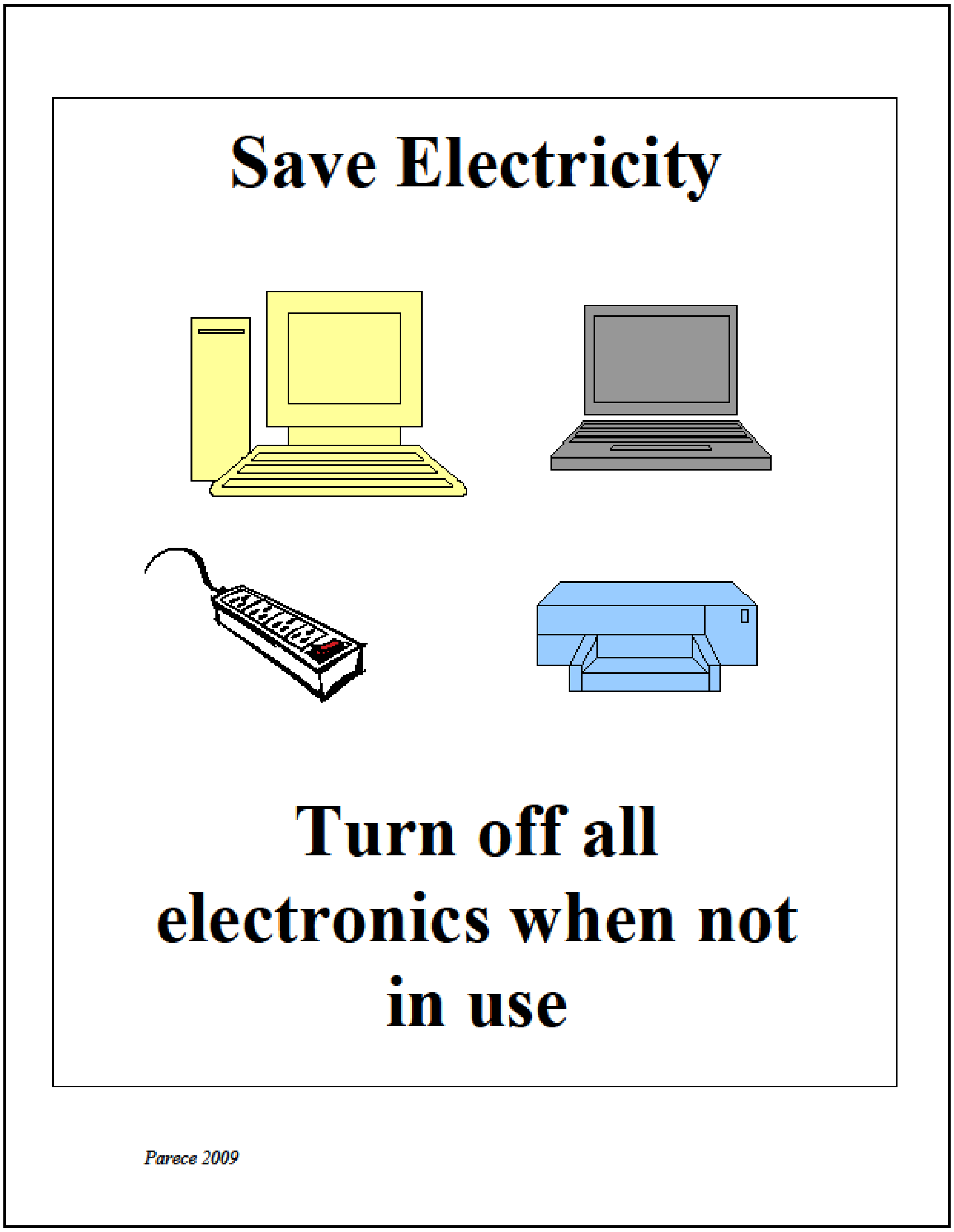


Figure A.8 Electricity Conservation Poster placed on bulletin boards
Source: Designed by author with Microsoft® ClipArt*

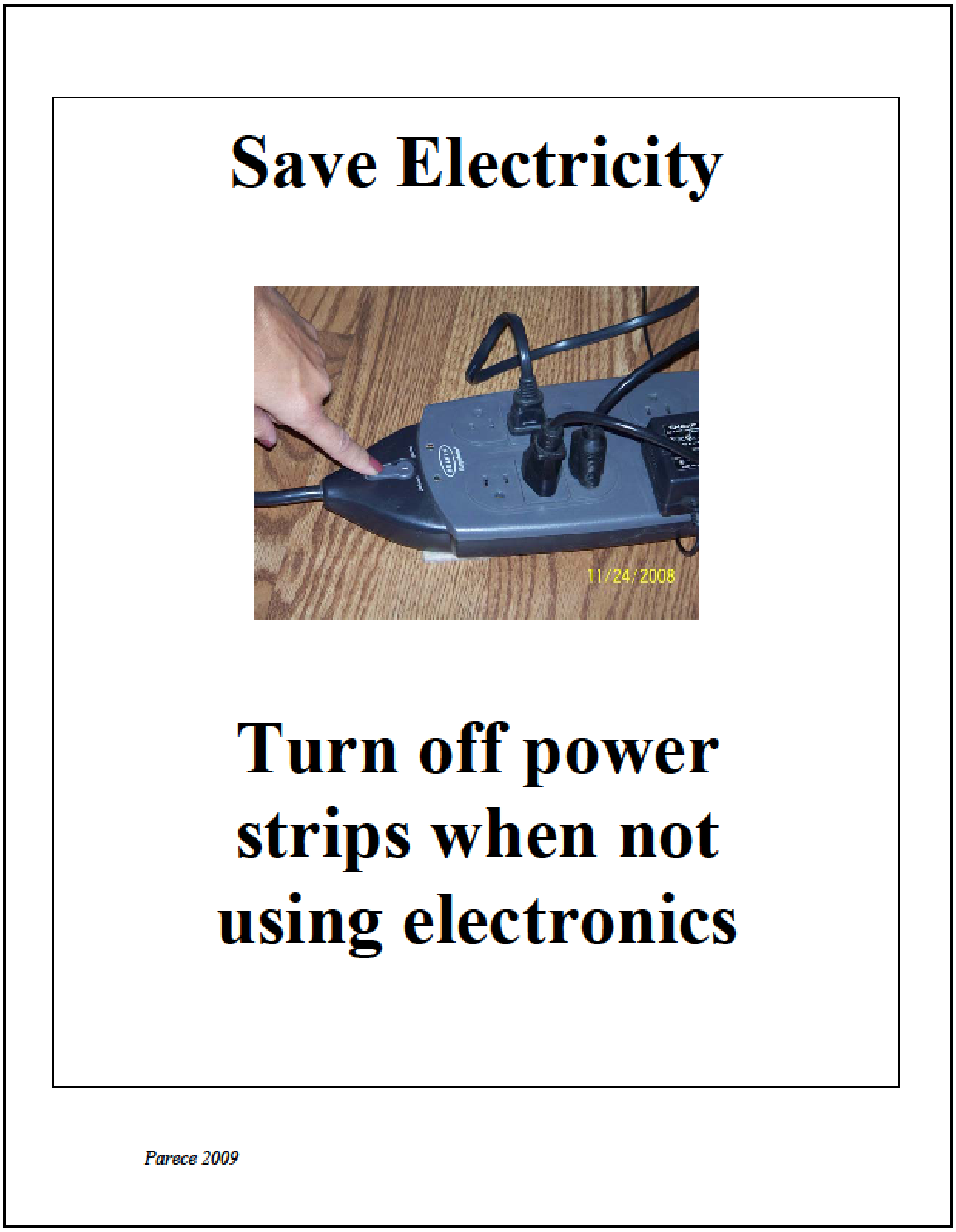
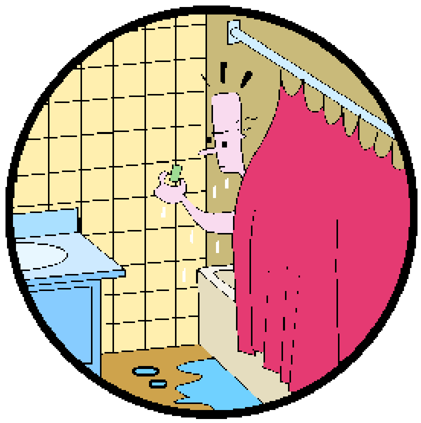


Figure A.9 Electricity Conservation Poster placed on bulletin boards
Source: Designed by author, Photo by author

Conserve Water



Reducing your shower time by a few minutes saves water!

Parece 2009

Figure A.10 Water Conservation Poster placed in bathrooms
Source: Designed by author with Microsoft® ClipArt*

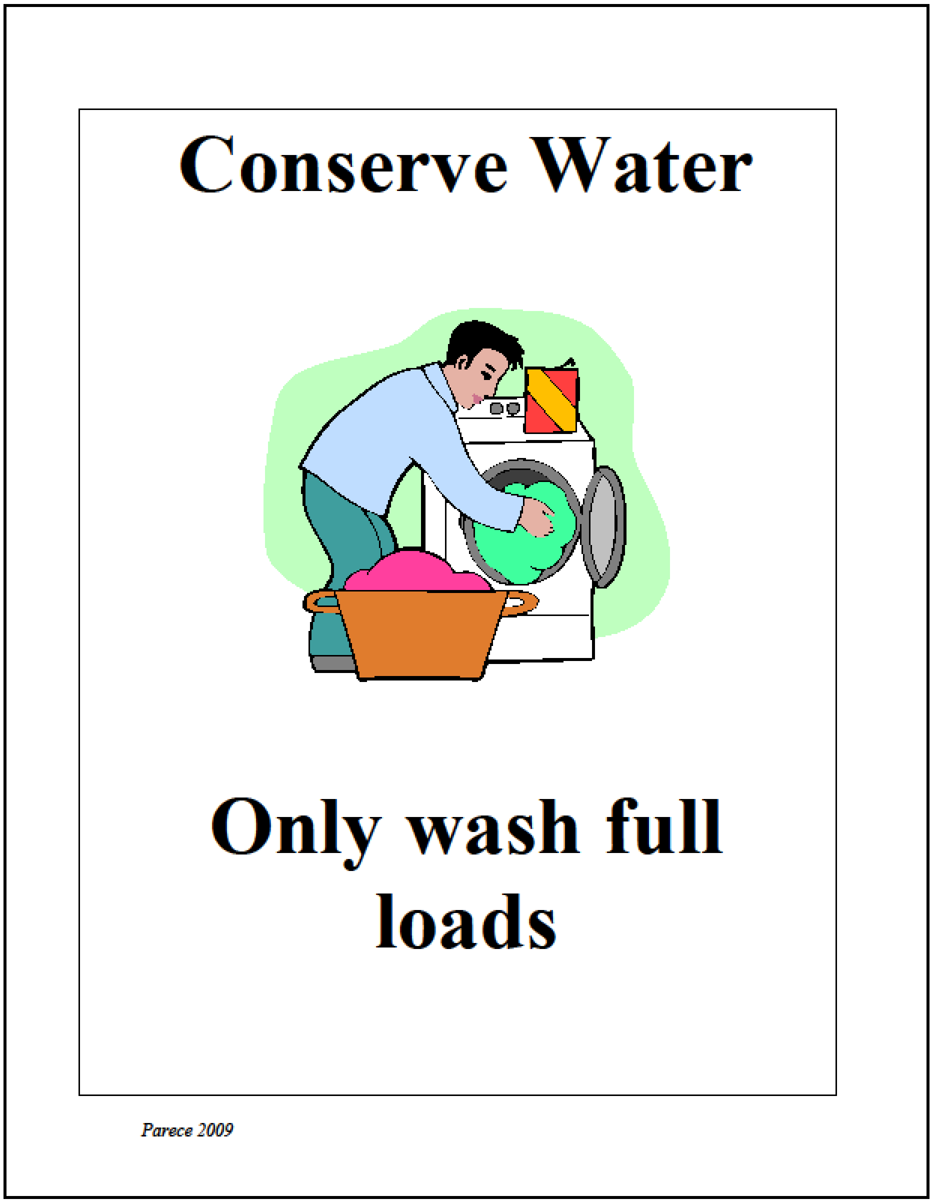


Figure A.11 Water Conservation Poster placed in laundry rooms
Source: Designed by author with Microsoft® ClipArt*

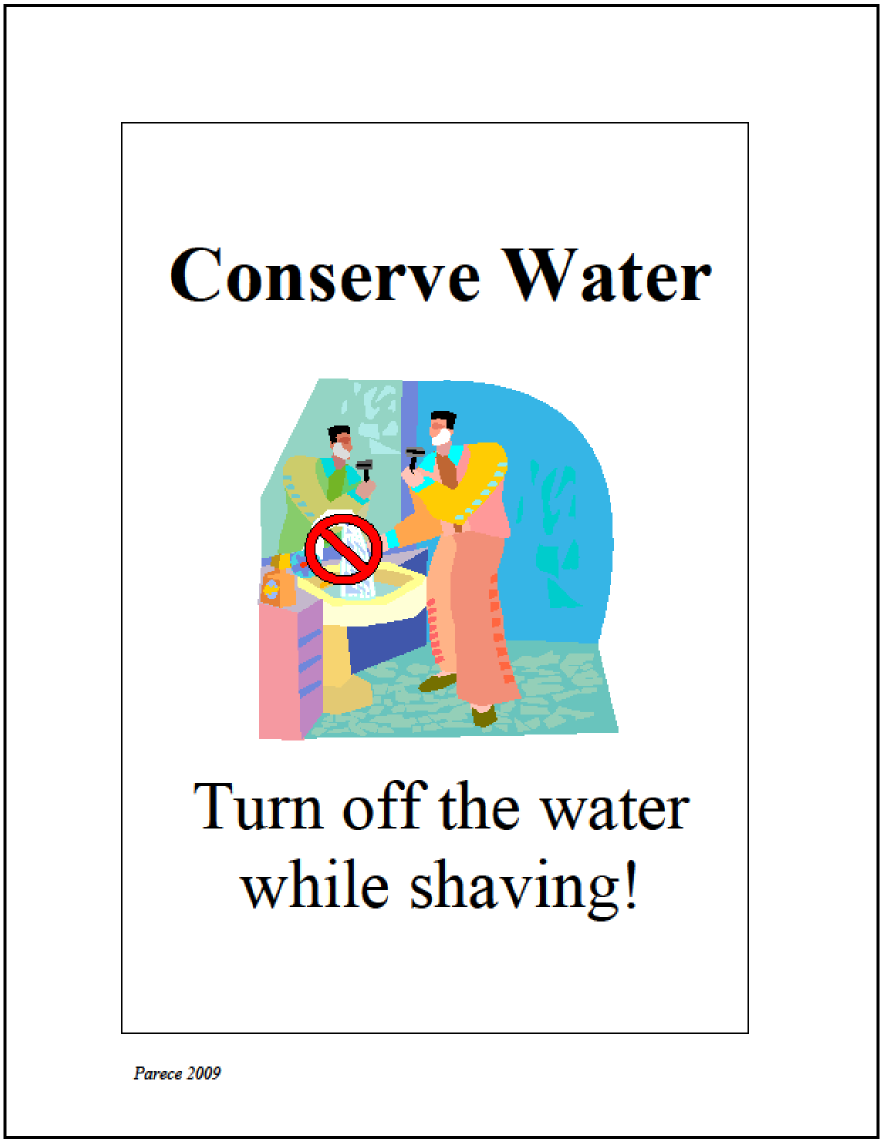


Figure A.12 Water Conservation Poster placed in bathrooms
Source: Designed by author with Microsoft® ClipArt*

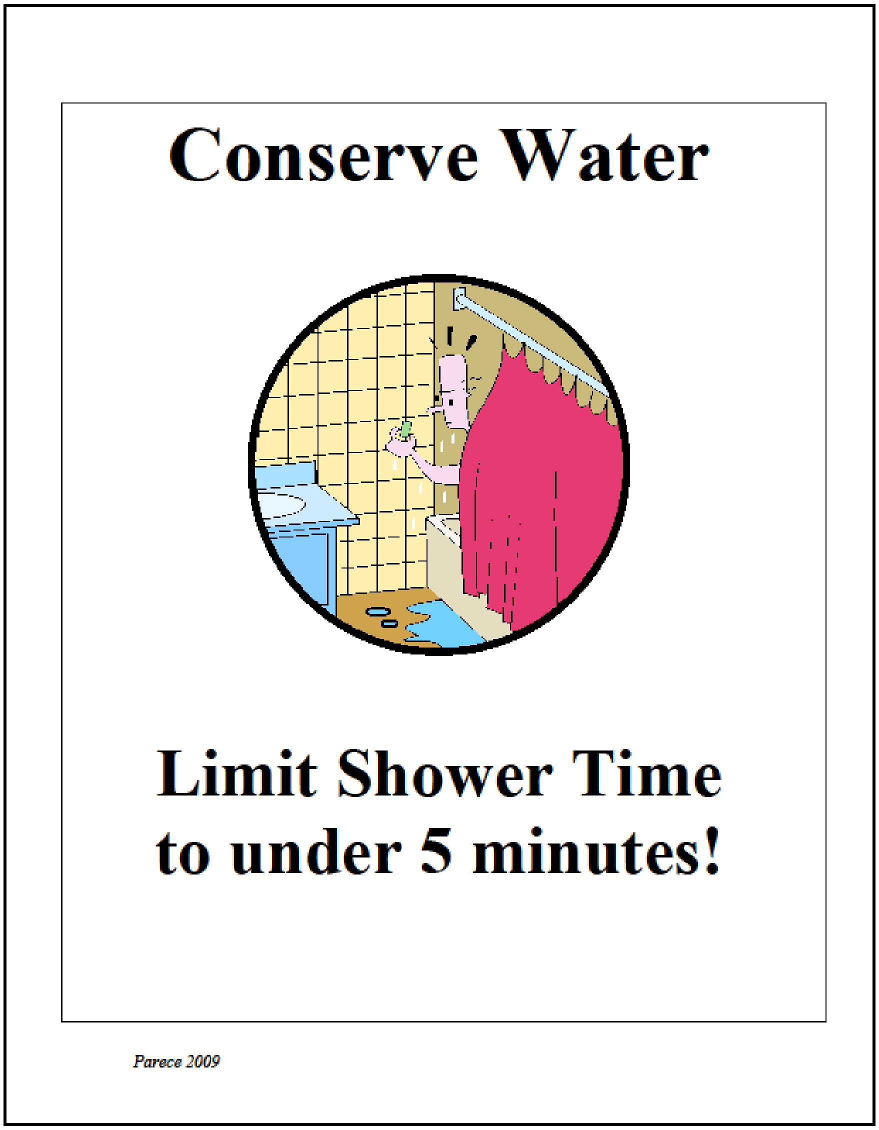


Figure A.13 Water Conservation Poster placed in bathrooms
Source: Designed by author with Microsoft® ClipArt*

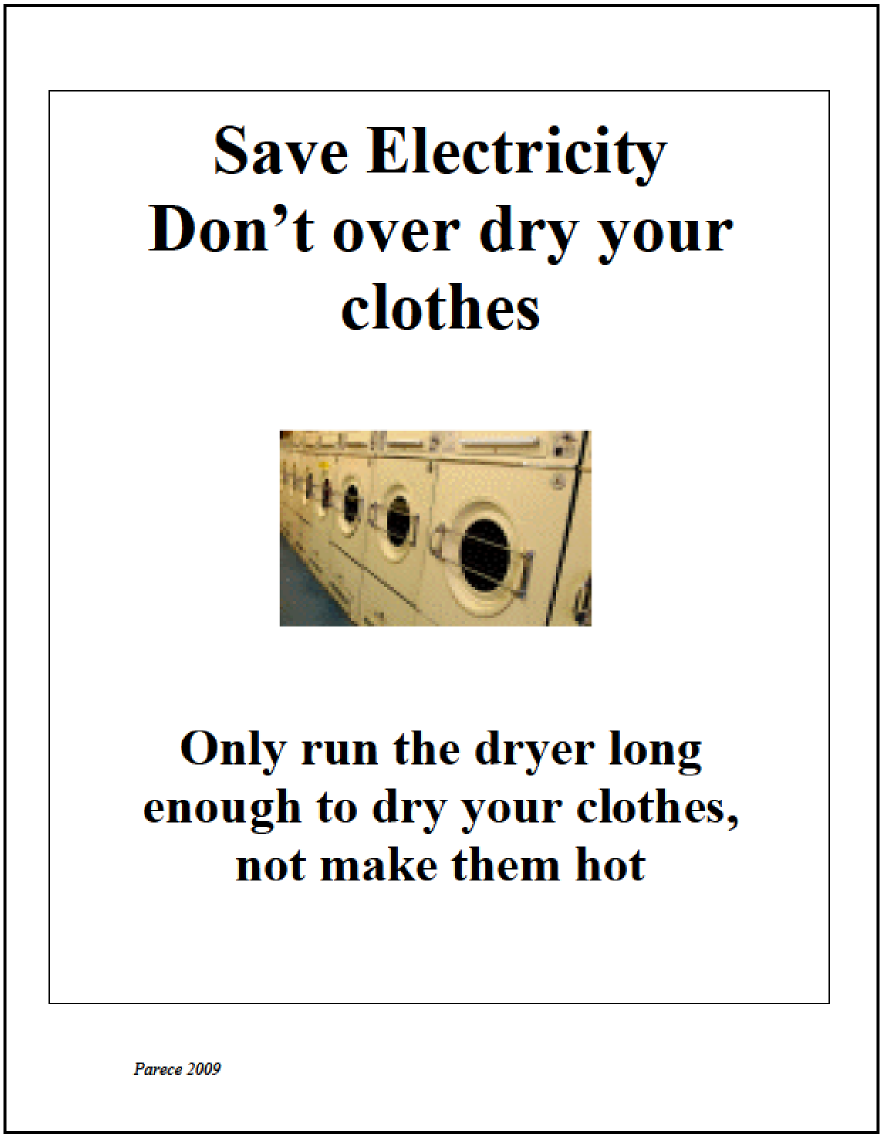


Figure A.14 Electricity Conservation Poster placed in laundry rooms
Source: Designed by author with Microsoft® ClipArt*

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