Building and Environment 44 (2009) 1707–1713

Contents lists available at ScienceDirect

Building and Environment

journal homepage: www.elsevier.com/locate/buildenv

The Utah House: An effective educational tool and catalyst for behavior change?

Michael E. Dietz [a,*], Jayne Mulford [b], Kerry Case [c]

[a] Department of Environment and Society, Utah State University, 5215 Old Main Hill, Logan, UT 84322-5215, USA
[b] Cooperative Extension, Utah State University, 920 South, 50 West, Kaysville, UT 84037, USA
[c] Environmental Center, Westminster College, 1840 South, 1300 East, Salt Lake City, UT 84105, USA

ARTICLE INFO

Article history:
Received 30 September 2008
Received in revised form
13 November 2008
Accepted 14 November 2008

Keywords:
Utah House
Demonstration house
Pro-environmental behavior

ABSTRACT

The Utah House in Kaysville, UT is a demonstration facility built and operated by Utah State University Cooperative Extension. It is designed to showcase alternative building techniques, with a focus on sustainable use of resources, energy and water conservation, healthy indoor air, and universal design. A survey was sent to visitors of the Utah House in January 2008. Questions were asked about knowledge of key topics, and engagement in selected pro-environmental behaviors, to determine if their visit to the house influenced their level of knowledge or more importantly, their behavior. Significant increases in self-reported knowledge were found for all five topic areas, indicating that the house was an effective educational tool. Differences in self-reported knowledge before the visit were found for gender and educational level, but mean ratings for all groups were essentially the same after the visit. Although many visitors had already engaged in at least one pro-environmental behavior before coming to the house (83%), a large percentage (63%) made at least one change as a result of their visit, indicating that the house was a catalyst for behavior change. Although several interesting correlations were found between knowledge, feelings and behavior, no strong predictor of behavior emerged.

1. Introduction

Although the environmental movement has ebbed and flowed since the 1960s, environmental concern or the "green movement" has crept its way into mainstream advertising, marketing and manufacturing. Public concern for environmental issues is high, yet people often cling to outdated or incorrect myths about environmental issues [1]. Recent increases in energy and food prices have made hybrid cars and energy-efficient homes common topics of discussion in the media.

Early environmental education efforts were largely based on the model that environmental knowledge led to increased environmental awareness, which then led to pro-environmental behaviors [2]. It has been noted that this linear progression is over simplified, and increases in knowledge and/or awareness do not necessarily lead to behavior changes [2,3]. However, a recent study on adolescents has shown a significant positive relationship between attitudes, knowledge and behavior [4]. Demographic variables such as education level have been found to be positively, but weakly correlated with pro-environmental behaviors [5,6]. Age has been found to be positively [5,7–9] and negatively [10] associated with pro-environmental behaviors. It seems that in general, women tend to engage more in pro-environmental behaviors than men [4,11–13], although this is not always the case [10]. Interestingly, although women tend to be the ones engaging in these behaviors more often, men have been found to have higher levels of knowledge on specific environmental issues [4,11]. This anomaly highlights the fact the increased knowledge does not necessarily lead to increased action. Engagement in pro-environmental behavior is increasingly seen to be a result of complex interactions between internal factors such as knowledge, desire to act, emotional responses, and external factors such as economic constraints, convenience of the activity, and social pressures [12,14–16]. Other variables, such as an internal locus of control (an individual's perception that their actions are likely to 'make a difference') have also been found to explain whether an individual engages in pro-environmental behavior [15].

Numerous tools and techniques have been utilized to provide environmental education to the public. For example, in the field of stormwater education, television, radio, and local newspapers were among the most effective tools for getting residents to recall a stormwater message, while brochures and handouts were among the least effective [17]. However, even among those techniques which are effective in inducing awareness of a program or recall of certain facts, very few take the next step and examine the impacts

* Corresponding author. Tel.: +1 435 797 3313.
E-mail addresses: michael.dietz@usu.edu (M.E. Dietz), jayne.mulford@usu.edu (J. Mulford), kcase@westminstercollege.edu (K. Case).

0360-1323/$ – see front matter © 2008 Elsevier Ltd. All rights reserved.
doi:10.1016/j.buildenv.2008.11.007

of the educational program on behavior changes in participants. Intensive education efforts, such as one-on-one direct interaction are often thought to be the most effective way to provide education and induce behavior change. However, this approach is time and money intensive, and high success rates are not guaranteed, as was found in one study in Connecticut [18].

The use of a demonstration facility has been advocated as an effective tool to bring about change in consumer choices and construction practices [19]. Several such buildings were constructed in Finland in the 1990s. The Utah House (http://theutahhouse.org) is Utah State University Extension's sustainable building demonstration and education center. The Utah House concept was based on that of the Florida Learning House (http://sarasota.extension.ufl.edu/FHLC/FlaHouseHome.shtml). The Utah House opened to the public in 2003, with a mission to demonstrate, educate, and empower the public about new ways of building homes and creating landscapes that promote energy efficiency, water conservation, healthy indoor environments, the sustainable use of all resources, and universal design principles. Universal design assumes that the facility should be built in such as way as to consider the needs of the widest array of users, including people of all ages, sizes, and abilities. Located at the Utah Botanical Center in Kaysville, the Utah House is open to the public for tours, workshops, youth groups, field trips, and event rental. More than 10,000 adults and children attended educational programs at the house in 2007.

The Utah House has numerous demonstrations of sustainable building techniques, energy and water conservation, healthy indoor air, and universal design:

Building materials:

- Forest Stewardship Council (FSC) lumber was used for framing materials.
- Engineered trusses were used to reduce waste.
- During construction, the majority of waste was recycled or reused.
- Concrete for the frost walls and slab had high recycled fly-ash content.
- Windowsills and bathroom counters were made of a locally made, recycled glass product.
- Straw bale and Insulated Concrete Forms were used for walls in the classroom.
- Reclaimed lumber was used for an arbor in the yard.

Energy conservation:

- Passive solar design was utilized.
- 1 kW solar photovoltaic system and solar hot water heating were installed.
- Ground source heating/cooling system was installed in the classroom.
- Light tubes and clerestory windows were installed throughout the house to increase natural light.
- Energy Star® appliances were installed, and the entire home was Energy Star certified.
- Compact fluorescent lighting was used throughout.

Water conservation:

- Low-flow toilets, faucets and washing machine were installed.
- Roof runoff is stored in a 6500-gallon cistern and is used to flush a toilet in the house.
- Point-of-use water heater was installed in the kitchen to reduce wasted water when waiting for hot water.
- Drought tolerant plants and a high efficiency irrigation system were used for landscaped areas.

Healthy indoor air:

- Low- or no-VOC paints were used throughout.
- Durable, formaldehyde-free materials were chosen for kitchen working surfaces.
- High-efficiency furnace filters were installed.
- Recycled carpet materials were installed.

Universal design:

- An open floor plan was utilized to allow movement for people with varying ability levels to move easily through the house.
- Thresholds on doors were avoided, and doors were wide enough to accommodate wheelchairs.
- Main bedroom has emergency access to the outside, spacious closets, smoke detector/visual strobe (for those with impaired hearing).

The use of a demonstration facility as an educational tool and catalyst for behavior change has not been evaluated in the literature. Thousands of adults and children have participated in the educational programs at the Utah House. To date, a preliminary online survey of visitors indicated increases in self-reported knowledge, and some changes in lifestyle at home. The objectives of this survey were to perform a more comprehensive analysis to determine if the Utah House is an effective educational tool, and also to assess in greater detail what changes visitors have made in their personal lives as a result of their visit to the Utah House.

2. Methods

2.1. Survey

Visitors to the Utah House have the option to leave contact information as they are leaving the site, so that they can be notified of upcoming events at the house. The key topics that are addressed during tours at the house are overall sustainability, energy efficiency, water conservation, healthy indoor air, and universal design. In January 2008, a three-page survey (see supplemental information) was sent out to 1636 people who had left their contact information at the house in the last three years. The survey was sent with a cover letter and a business reply envelope. The cover letter explained the survey, and offered a random drawing for prizes (three $50 gift certificates) for those who returned it.

The survey was designed to assess several areas: how people *feel* about the key topics, did their visit to the Utah House change their level of *knowledge* about each topic, and what have they actually *done* in response to their visit. Other questions were also included such as what types of programs each person participated in while at the house (workshop, self-guided tour, guided individual tour, K-12/youth activity, small group tour, larger group tour), how long ago they visited, how often they visit, why they haven't done the listed actions (too busy, too expensive, need more information, don't feel it's that important, other), and demographic information (gender, age group, home ownership status, ethnicity, and education level). A number of other questions were included to obtain information for the house and the educational programs, such as their rating of our teaching, types of workshops they would attend in the future, and other suggestions.

The questions about knowledge change and how they feel about the topics were posed with the five key topic areas, and a five-point scale. For the knowledge questions, 1 was labeled "Nothing", and 5 was labeled "A lot". For the question on how important each topic is, each number had a label (1 = Not important at all, 2 = Somewhat important, 3 = Important, 4 = Very important, 5 = Extremely important). The rating of our teaching also had

a label for each number (1 = Poor, 2 = Fair, 3 = Good, 4 = Very good, 5 = Excellent). The question about actions that they have taken was listed in a matrix format. Actions that are highlighted in the house were listed in rows, such as "Install compact fluorescent lighting", or "Install an efficient irrigation system", along with three columns that were labeled "I did this *before* visiting the Utah House", "I have done this *because of what I learned* at the Utah House", and "I plan to do this *in the future*".

2.2. Statistical analysis

All statistical analyses were performed using SPSS [20], version 16.0.1. Survey results were entered by hand into a SPSS file. To assess whether visitors' knowledge of each of the key topic areas increased, a paired *t*-test was used to compare their stated level of knowledge before the visit, and their stated level of knowledge after the visit. An unpaired *t*-test was used to assess differences in knowledge before and after a visit, by gender. Analysis of variance (ANOVA) and mean separation (Bonferroni) was performed on knowledge ratings for the different levels of education groups to determine if significant differences existed. Cross-tabulations were performed on several variables, and the Chi-square statistic was used to determine if there were significant differences in the comparisons. A significance level (*p*-value) of <0.05 for all statistical tests performed was considered significant. The remaining data were summarized in terms of mean responses, standard deviations, and sums.

3. Results

Of the 1636 surveys that were sent out, 5 were returned as undeliverable and 254 were returned completed, for a response rate of 15.5%. A large number of respondents had visited the house within the last year (41.5%). A smaller percentage (28.5%) stated that they had visited 1–2 years ago, and 30.0% visited more than 2 years ago.

3.1. Demographics

In general, the survey respondents were predominantly Caucasian (92.9%), aged 45–64 (55.1%), female (70.1%), and highly educated (Figs. 1 and 2). The ethnicity of this group reflects the predominantly Caucasian (92%) population of Davis County (U.S. Census, 2000). Initially, it was not clear whether the typical visitors to the Utah House were middle-aged women, or whether this

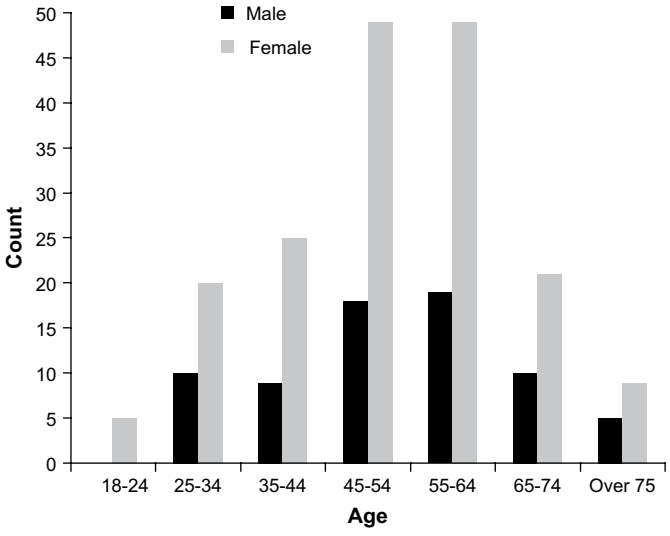

Fig. 1. Age and gender of survey respondents.

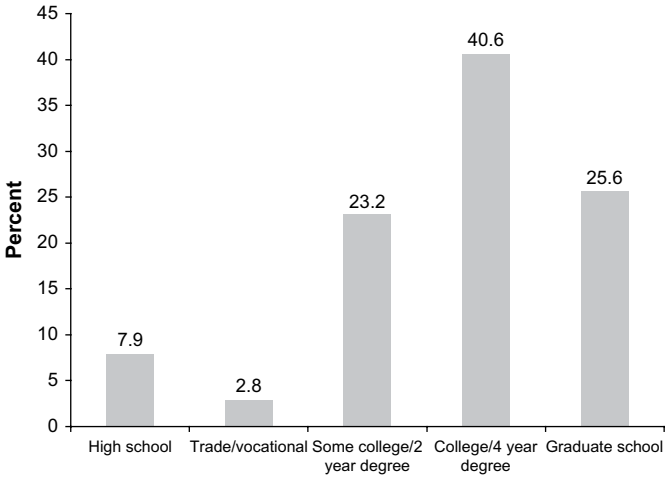

Fig. 2. Highest level of education of survey respondents.

group was more likely to have completed the survey. A review of visitor logs at the Utah House indicated a slightly higher percentage of female visitors (56%) compared to male visitors (44%), but the difference was not as great as the difference in gender of survey respondents. Therefore, it appears that women were more likely to put their names on our mailing list, and/or return the survey. The visitor logs also indicated that around 17,200 visitors (excluding children's field trips) came to the house from 2005 to 2007. A statistical test of confidence can be performed on the number of respondents compared to visitors. Assuming 95% confidence, and a population of 17,200 visitors, a confidence interval of 6% is found for this study (www.surveysystem.com/sscalc.htm).

3.2. Knowledge change, importance, and rating of teaching

Comparisons (*t*-test) of self-reported knowledge on the five key topics taught at the Utah House before and after a visit indicated significant ($p = 0.001$) increases in knowledge for all five topic areas (Fig. 3). In general, respondents came in with more knowledge (higher mean rating) in energy efficiency and water conservation than in the other three areas, but the differences were small. Respondents reported low levels of knowledge about universal

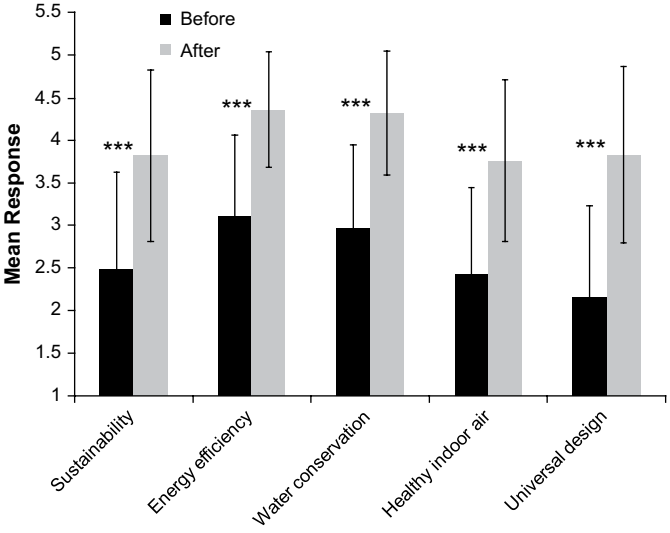

Fig. 3. Mean self-reported knowledge of key topics before and after visit to the Utah House. Asterisks indicate a significant difference using a *t*-test (***p-value=0.001). Error bars are ±1SD.

design before visiting the house (mean = 2.2); however the visit to the house increased their knowledge level to 3.8 (Fig. 3).

There were several differences found in self-reported knowledge of the five topic areas. Male visitors reported significantly higher levels of knowledge before their visit for all of the topic levels except universal design (Fig. 4). Men have been found to have higher levels of knowledge on specific environmental topics [4,11], although the present study does not use an actual test of knowledge, only self-reported knowledge. Interestingly, after the visit the only significant difference between male and female visitors was on the topic of sustainability (Fig. 5). Differences were also found for visitors with varying levels of education: ANOVA analysis revealed that self-reported knowledge on sustainability and healthy indoor air was higher for college graduates than for those who did not attend college (Table 1). However, after the visit, there were no significant differences in self-reported knowledge for any of the topics across education levels (Table 1). Although these ratings are only for *self-reported* knowledge, and are limited as such, these findings show that after a visit to the facility, visitors left with a uniform level of knowledge, independent of gender or educational background.

In general, survey respondents felt that energy efficiency and water conservation were more important to them, but the differences were slight (Fig. 6). Mean responses for all five key topic areas were between 3.6 and 4.5, indicating a high level of concern for all of the topic areas.

Mean ratings of the teaching of all five key topic areas at the Utah House were above 3.5, indicating that in general respondents felt that the staff at the Utah House did a good to very good job of teaching the topic areas. Teaching of energy efficiency and water conservation were rated highest (mean responses = 4.0). Interestingly, the mean response for teaching of universal design was lower than the others at 3.7, yet respondents reported the greatest increase in knowledge for this topic area (Fig. 3).

3.3. Actions before visit

The target actions from the survey are listed in Table 2. Many of the respondents reported doing some of these activities before visiting the house; 82.7% reported doing at least one of these actions before their visit. The most common actions were installation of the following: compact fluorescent lighting (52.4%),

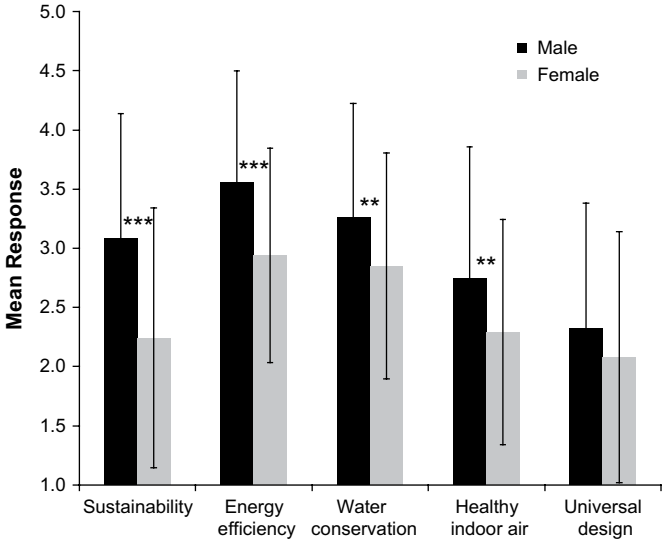

Fig. 4. Mean self-reported knowledge of key topics *before* visit, by gender. Asterisks indicate a significant difference using a *t*-test (**p-value=0.01, ***p-value=0.001). Error bars are ±1SD.

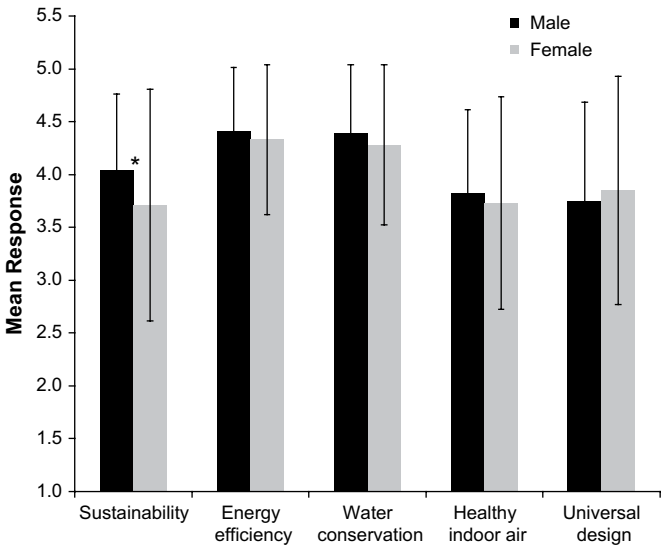

Fig. 5. Mean self-reported knowledge of key topics *after* visit, by gender. Asterisks indicate a significant difference using a *t*-test (*p-value=0.05). Error bars are ±1SD.

water- efficient toilets or faucets (37.4%), more insulation in the home (29.1%), an efficient irrigation system (24.4%), and low-water landscape plants (23.2%) (Table 2). One determinant of whether people perform the actions seems to be how strongly they feel about the key topic areas, or their level of environmental concern. The number of actions that people had done before visiting the house was significantly ($p = 0.01$) correlated with the average of their ratings of how important each of the topic areas was to them. Although this relationship is not strong (Pearson correlation coefficient = 0.175), the relationship is significant, indicating some

Table 1
Mean self-reported knowledge of key topics before and after visit, by educational level. Means followed by the same letters are not significantly different from each other at p=0.05 using Bonferroni's mean separation test.

Topic area	Education level	Mean before visit	Mean after visit	Difference
Sustainability	High school	1.8 cd	3.5 a	1.7
	Trade/vocational	2 abcd	3.7 a	1.7
	Some college/2-year degree	2.1 ac	3.9 a	1.8
	College/4-year degree	2.7 ab	3.8 a	1.1
	Graduate school	2.7 a	3.9 a	1.2
Energy efficiency	High school	2.9 a	4.2 a	1.3
	Trade/vocational	2.6 a	4.2 a	1.6
	Some college/2-year degree	2.9 a	4.4 a	1.5
	College/4-year degree	3.3 a	4.4 a	1.1
	Graduate school	3.2 a	4.3 a	1.1
Water conservation	High school	2.7 a	4.1 a	1.4
	Trade/vocational	3.3 a	4.2 a	0.9
	Some college/2-year degree	2.7 a	4.3 a	1.6
	College/4-year degree	3.1 a	4.4 a	1.3
	Graduate school	3 a	4.3 a	1.3
Healthy indoor air	High school	2.2 abc	3.3 a	1.1
	Trade/vocational	2 abcd	3.3 a	1.3
	Some college/2-year degree	2.2 bcd	4 a	1.8
	College/4-year degree	2.6 a	3.8 a	1.2
	Graduate school	2.4 ab	3.8 a	1.4
Universal design	High school	1.8 a	3.7 a	1.9
	Trade/vocational	2.3 a	3.7 a	1.4
	Some college/2-year degree	1.9 a	4.2 a	2.3
	College/4-year degree	2.3 a	3.8 a	1.5
	Graduate school	2.2 a	3.7 a	1.5

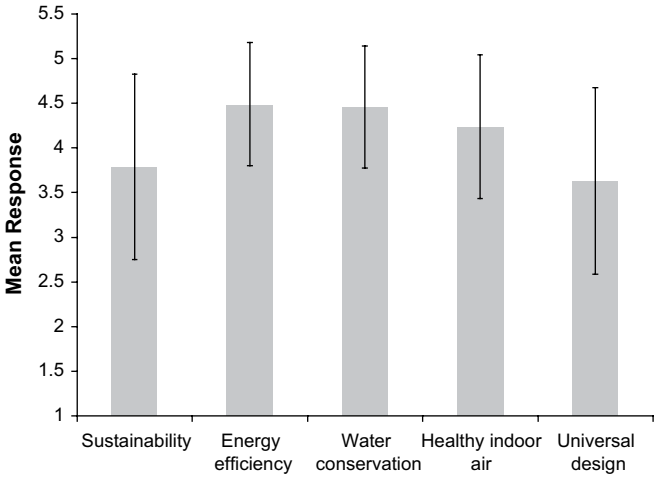

Fig. 6. Mean response of how important each topic is to respondents. Error bars are ±1SD.

linkage between how important the respondents believe the issues are and the number of actions that they had implemented. This is not surprising given other research on correlations between environmental concern and environmental behavior: a meta-analysis of research on determinants of pro-environmental behavior revealed an average correlation coefficient of 0.347 ± 0.224 between attitudes on environmental issues and engagement in pro-environmental behaviors [15].

Self-reported knowledge of two of the topic areas was also found to be significantly correlated with specific related actions. For example, the self-reported knowledge of water conservation before the visit to the house was significantly correlated ($p = 0.01$, Pearson correlation coefficient $= 0.333$) with the number of water conservation actions performed before the visit. These actions included installation of water- efficient toilet or faucet, purchase of a front-load washer, installation of an efficient irrigation system, and changing landscape plants to native or low-water demand type. The same relationship was found for energy efficiency: self-reported knowledge of energy efficiency before the visit was significantly ($p = 0.01$, Pearson correlation coefficient $= 0.386$) correlated with the number of actions related to energy efficiency performed before the visit. These actions included installation of compact fluorescent lighting, installation of light tubes, installation of solar panels for electricity or hot water generation, installation of a ground-source heat pump, and installation of more insulation in the home. In general, the positive coefficients suggest that the more knowledge people had of a particular issue, the more likely they were to engage in activities that addressed the issue. These findings are consistent with literature values of correlations between knowledge and engagement in environmental behaviors: an average correlation coefficient of 0.299 ± 0.195 between knowledge and behavior has been reported [15]. Although the reported range in correlations is quite wide, the results of the present study are very close to the reported mean from the meta-analysis.

Table 2
Percent of respondents performing target actions, and future intention.

	I did this *before* visiting the Utah House	I have done this *because of what I learned* at Utah House	I plan to do this *in the future*
Install compact fluorescent lighting	52.4	26.4	13.0
Install light tubes	18.5	8.7	25.6
Install a water efficient toilet or faucet	37.4	16.1	25.6
Purchase a front load washer	14.6	12.6	40.6
Install a solar panel for electricity	2.0	2.0	41.7
Install a solar panel for hot water	1.6	0.8	37.8
Purchase green power through power company	8.7	5.5	23.2
Install an efficient irrigation system	24.4	11.4	29.1
Change landscape plants to native or low-water demand type	23.2	27.6	29.5
Install a recycled carpet product	5.1	3.9	26.0
Install a recycled counter top	1.2	2.8	28.7
Install a rain barrel or cistern for landscape irrigation	3.5	3.5	34.6
Install a ground source heat pump	0.4	0.8	20.9
Install more insulation in my home	29.1	9.4	29.9
Use low- or no-VOC paint	7.5	6.7	25.6

Cross-tabulations for engagement in specified activities before the visit by gender and age indicated that there were no differences for men between expected and actual counts (Chi-square). However, a significant difference ($p = 0.05$) was found for women: actual counts were higher than expected for engaging in any activity for both the 35–44 and the 45–54 age groups. These results indicate that middle-aged women were significantly more likely than other age groups to be engaging in the listed activities *before* their visit to the house. Women were found to be more likely to engage in pro-environmental behavior in other studies [4,11–13], although the relationship was weak in general [15].

Educational level has also been found to be weakly correlated (correlation coefficient 0.185 ± 0.122) with pro-environmental behavior [15]. In the present study, education level was not significantly correlated with the number of specific environmental actions performed before the visit to the Utah House.

3.4. Actions as a result of visit

A substantial number of people reported implementing at least one of the actions (63.0%) as a result of their visit to the Utah House. The most common actions were installation of low-water use landscape plants (27.6%), compact fluorescent lighting (26.4%), and water efficient toilets or faucets (16.1%). This finding is consistent with another study which found convenience of the activity to be positively related to engagement [12]. Not surprisingly, actions with high up-front costs such as installing solar panels for electricity or hot water were not highly implemented, either before or after the visit. However, these two actions were the highest rated actions that people plan to do in the future, with a high percentage of respondents stating that they planned to install solar panels for electricity (41.7%) or hot water (37.8%) (Table 2). Installation of a ground-source heat pump is also an expensive up-front cost, and less than 1% of respondents had installed this before their visit, or as a result of their visit. However, nearly 21% of respondents stated that they planned on doing this in the future.

In contrast to the cross-tabulations for engagement in activities by gender and age *before* the visit, cross-tabulations for engaging in any activity *as a result of* the visit indicated no significant differences for women, but a significant difference ($p = 0.05$) for men. Fewer than expected men in the 25–34 age group made a change, and more men in the 45–54 age group made a change as a result of their visit to the Utah House.

A significant but weak correlation was found between increases in self-reported knowledge *after* the visit to the house (the calculated difference between knowledge before and knowledge after the visit) and the number of related actions performed *as a result of* the visit. The increase in knowledge of energy efficiency was significantly ($p = 0.01$, Pearson correlation coefficient $= 0.178$)

correlated with the number of actions related to energy efficiency performed as a result of the visit. However, no significant correlations were found between increases in knowledge of water conservation and related behaviors.

When asked why they did *not* do the activities listed (if they in fact, had not), the most common reason was the cost (44.1%), followed by the need for more information (21.7%). Another reason frequently listed for not doing the actions was that people were either renting, or have a home that does not currently need upgrades (9.8%).

3.5. Participation in different programs at the Utah House

Cross-tabulations were performed on the participation in each type of activity at the Utah House by whether a person performed at least one of the actions on the list as a result of their visit. It should be noted that participants could participate in different types of activities. Therefore, statistically, the groups of different types of activities are not independent. Interestingly, the only significant association was for participants in large group tours: those who participated in a large group tour were significantly ($p = 0.05$) *less likely* to engage in at least one of the target activities. The reason for this association is unclear; however it is not likely that participation in the large group tour *caused* visitors to not engage in a target activity. If smaller group or guided tour activities had a significant association with engagement in target activities, it could be assumed that increased interaction with a guide might influence behaviors at a later date. However, no such associations were found, so the large group association is difficult to explain.

A relationship was found between the number of different types of activities (sum) that participants engaged in at the Utah House, and whether they performed at least one of the desired actions. The correlation was weak (Pearson correlation coefficient = 0.137), but significant ($p = 0.05$). This relationship makes sense given the complex factors cited in the literature as determinants for pro-environmental behavior [15,16]; if a person engaged in varying activities such as individual tours where they could learn at their own pace, guided tours where they could have personal interaction, and workshops where they deepen their knowledge, they would perhaps be more likely to engage in target behaviors.

4. Discussion

Several limitations to the Utah House survey exist. First, the level of knowledge measured was self-reported. It may be difficult for people to remember what they knew before and after their visit, especially since 30% of respondents had visited the Utah House more than two years ago. Also, behaviors were self-reported, although the actions in the survey were ones that would be likely be easy to recall (e.g., changing landscaping, installing a new washer). Respondents to the survey were skewed towards highly educated, middle-aged women. Despite the limitations, the authors contend that the findings from this study have value. The knowledge increases found are still a good assessment of what people feel they learned at the facility, even if the changes in knowledge were not specifically quantified. Also, there were enough men and younger people who responded to perform valid statistical comparisons on gender and age cross-tabulations.

Although several statistically significant relationships were found between visitors' knowledge of issues, how important they think the issues are, and the number of actions that they performed, no strong predictor of engagement in pro-environmental behavior emerged. This is consistent with literature findings, where correlations between pro-environmental behavior and certain variables have been found; however a linear progression from knowledge to awareness to action has not been supported [3,7,21]. For example, the authors of the meta-analysis of research on determinants of pro-environmental behavior concluded that knowledge of an issue appears to be a prerequisite to action, but other complex factors such as desire to act, economic constraints, and social pressures can interact in different ways to determine a behavior outcome [15]. Other variables, such as an internal locus of control (an individual's perception that their actions are likely to "make a difference") also were found to be positively correlated with pro-environmental behavior [15]. In a study of waste reduction behaviors, numerous environmental values, situational characteristics, and psychological factors explained some variance in waste reduction behavior; however the majority of the variance in behavior was unexplained [7].

Significant increases in self-reported knowledge from before to after visiting the Utah House were found for all of the key topic areas listed, which included sustainability, water conservation, energy efficiency, healthy indoor air, and universal design. Male visitors reported significantly higher levels of knowledge for most of the topics before their visit than females, and visitors with more education reported higher levels of knowledge for some topics before their visit; however the self-reported knowledge levels were virtually indistinguishable for all groups after the visit.

The majority of respondents (83%) reported performing at least one of the target behaviors before their visit to the house. Respondents' level of environmental concern was weakly correlated with the number of actions they had performed, indicating that concern was somehow involved with the decision to act. Self-reported knowledge of water conservation and energy efficiency was also correlated with the number of related actions performed before the visit, indicating that knowledge also was a precursor to pro-environmental behavior. Middle-aged women were more likely than other ages or than men to report engagement in pro-environmental behaviors before their visit.

A large percentage of respondents (63%) reported engaging in at least one target behavior as a result of their visit. Not unexpectedly, the least expensive, easiest to implement activities were the most popular. Convenience was a significant factor in willingness to engage in electronics recycling [12]. No differences in behavior engagement were noted for men; however fewer men than expected in the 25–34 age group engaged in target behaviors. A weak correlation was found in knowledge increase for energy efficiency, and engagement in energy efficient activities. Given the weak relationship for energy efficiency topics and lack of relationship for water conservation topics, this suggests that the knowledge of the topics gained at the Utah House was not the primary driver behind the behavior changes noted. This is consistent with the literature in which wide ranges of correlations (average correlation 0.299 ± 0.195) have been found for the relationship between knowledge and behavior [15].

In general, no strong associations were found between the type or number of activities in which the respondents participated, and whether they engaged in pro-environmental behaviors. Unexpectedly, it was discovered that those who had participated in a large group tour were less likely to engage in any pro-environmental behavior. The cause of this association was unclear.

Although changes in targeted behaviors were found for those who visited the Utah House, a substantial percentage (37%) of visitors did nothing as a result of their visit. This may be due to the high percentage (83%) of visitors who had engaged in at least one of the actions before their visit to the house. Several statistically significant correlations were found that could explain whether a person would engage in targeted pro-environmental behaviors, but no strong predictor emerged. This is consistent with the literature in which the decision to act has been found to be a complex blending of demographics, values, intentions, situational characteristics, and psychological factors.

The Utah House has been very successful at providing educational activities to the public through the demonstration site, and moderately successful at encouraging pro-environmental behaviors. If increases in targeted pro-environmental behaviors are desired, it seems that other strategies may be more appropriate to encourage greater implementation. The community-based social marketing technique advocated by McKenzie-Mohr [21], which merges knowledge from psychology with social marketing, seems to have great potential. The technique involves identification of barriers, selecting target behaviors, designing strategies, piloting programs, then evaluating the programs [21]. Behavior changes in the general population have been recognized as necessary to achieve a more sustainable future [1]. Techniques such as community-based social marketing may actually lead us in a direction where the desired changes can occur more readily.

A distinction has been made in the literature between pro-environmental behavior and the actual environmental impact associated with that action [22]. The authors of one study reported that engagement in pro-environmental behaviors was significantly but weakly correlated (Pearson correlation coefficient = 0.22) with household energy use [23]. This finding supports efforts to select specific behaviors that will have the most benefit, as suggested by McKenzie-Mohr [21]. As a result of the present study, the managers of the Utah House intend to increase educational efforts in the house related to specific actions that people can do themselves, and that will have the most environmental benefit. The house as it is has been a wonderful resource for people seeking to build a new house, or modify their existing house. Most people are not usually making major modifications to their house at any given time. However, there are other lifestyle choices that can be targeted, such as food, transportation, and waste management choices that can be performed at any time. A future study is planned to measure the impacts of these educational efforts at the Utah House.

The Utah House was found to be a successful educational tool, and a catalyst for pro-environmental behaviors. Other techniques, such as community-based social marketing, were identified to perhaps increase the influence of the programs at the Utah House, and foster greater positive environmental impact.

Acknowledgments

The authors would like to acknowledge the hard work and dedication of Leona Hawks who made the Utah House a reality, and also the efforts of numerous volunteers and interns that have contributed to the success of the Utah House since its inception.

References

[1] Coyle K. Environmental Literacy in America. Washington, DC: The National Environmental Education & Training Foundation; 2005.
[2] Ramsey CE, Rickson RE. Environmental knowledge and attitudes. Journal of Environmental Education 1976;8(1):10–8.
[3] Hungerford HR, Volk TL. Changing learner behavior through environmental education. The Journal of Environmental Education 1990;21(3):8–21.
[4] Meinhold JL, Malkus AJ. Adolescent environmental behaviors: can knowledge, attitudes, and self-efficacy make a difference? Environment and Behavior 2005;37(4):511–32.
[5] Lansana FM. A comparative analysis of curbside recycling behavior in urban and suburban communities. Professional Geographer 1993;45:169–79.
[6] Vining J, Ebreo A. What makes a recycler? A comparison of recyclers and nonrecyclers. Environment and Behavior 1990;22:55–73.
[7] Barr S. Factors influencing environmental attitudes and behaviors. Environment and Behavior 2007;39(4):435–73.
[8] Derksen L, Gartrell J. The social context of recycling. American Sociological Review 1993;58:434–42.
[9] Granzin KL, Olsen JE. Characterising participants in activities protecting the environment: a focus on donating, recycling, and conservation behaviours. Journal of Public Policy and Marketing 1991;10:1–27.
[10] Theodori GL, Luloff AE. Position on environmental issues and engagement in proenvironmental behaviors. Society & Natural Resources 2002;15(6):471–82.
[11] Tikka PM, Kuitunen MT, Tynys SM. Effects of educational background on students' attitudes, activity levels, and knowledge concerning the environment. Journal of Environmental Education 2000;31(3):12–9.
[12] Saphores J-DM, Nixon H, Ogunseitan OA, Shapiro AA. Household willingness to recycle electronic waste: an application to California. Environment and Behavior 2006;38(2):183–208.
[13] Hunter LM, Hatch A, Johnson A. Cross-national gender variation in environmental behaviors. Social Science Quarterly 2004;85(3):677–94.
[14] Edgerton E, McKechnie J, Dunleavy K. Behavioral determinants of household participation in a home composting scheme. Environment and Behavior 2008; in press.
[15] Hines JM, Hungerford HR, Tomera AN. Analysis and synthesis of research on responsible environmental behavior: a meta-analysis. The Journal of Environmental Education 1986;18(2):1–8.
[16] Kollmuss A, Agyeman J. Mind the gap: why do people act environmentally and what are the barriers to pro-environmental behavior? Environmental Education Research 2002;8(3):239–60.
[17] Swann CP. A survey of nutrient behavior among residents in the Chesapeake Bay Watershed, In: National Conference on Tools for Urban Water Resource Management & Protection, Chicago, IL.U.S. Environmental Protection Agency, Office of Research and Development EPA/625/R-00/001; 2000.
[18] Dietz ME, Clausen JC, Filchak KF. Education and changes in residential nonpoint pollution. Environmental Management 2004;34(5):684–90.
[19] Kua HW, Lee SE. Demonstration intelligent building—a methodology for the promotion of total sustainability in the built environment. Building and Environment 2002;37(3):231–40.
[20] SPSS for Windows. Rel. 16.0.1. Chicago: SPSS Inc; 2007.
[21] McKenzie-Mohr D. Promoting sustainable behavior: an introduction to community-based social marketing. Journal of Social Issues 2000;56(3):543–54.
[22] Stern PC. Toward a coherent theory of environmentally significant behavior. Journal of Social Issues 2000;56(3):407–24.
[23] Gatersleben B, Steg L, Vlek C. Measurement and determinants of environmentally significant consumer behavior. Environment and Behavior 2002;34(3):335–62.