DETERMINING ADEQUATE INFORMATION FOR GREEN BUILDING OCCUPANT TRAINING MATERIALS

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ABSTRACT

As knowledge of the built environment's impact on resource and energy use increases, industry leaders are moving toward a healthier, more sustainable solution by building green. Though green buildings have the ability to improve occupant health and productivity, it is not clear what impact the behaviors of building occupants have on the building. New systems and technologies in green buildings require building occupants to think and operate differently in their new green environment, otherwise risking not fully gaining the benefits of the new facility. The new behaviors necessary to the success of the green building are not necessarily obvious or trivial. They cannot simply be learned "on-the-job;" rather the transformation will require formal education. It likely requires changing attitudes and beliefs in addition to building a robust understanding of new procedures. This study sought to determine the amount of information necessary to change occupants' willingness to use new energy-efficient behaviors not followed in the conventional building. An empirical test comparing four versions of the same training, each with varying amounts and types of information was presented to three different populations: nursing staff of a green building, clinical staff of a green building, and nursing staff of a conventional building. Results show that knowledge of green building standards and the impact of energy saving behaviors are the information necessary to increase willingness to change behaviors. Also, staff members of the new, green building are more willing to change behaviors than staff of the conventional building.

KEYWORDS

green building, LEED, workplace training, occupant behavior, sustainable behavior

INTRODUCTION

Currently, the built environment has significant environmental impacts. Buildings consume natural resources and create waste, while reducing natural land and creating artificial environments for people to live and work in. Buildings use 40% of raw materials globally, equating to 3 billion tons annually (Roodman & Lenssen, 1995) and represent over 30% of U.S. primary energy use (U.S. Department of Energy, 2008). While green buildings have the potential to reduce these impacts, an important component beyond their design is their use. Building occupants can influence the footprint of their building. This study evaluates the appropriate methods of training building occupants to achieve greener behaviors.

Case Study

University of Pittsburgh Medical Center (UPMC) has shown its concerned for the environmental well being of its staff and patients by following the Leadership in Energy and Environmental Design (LEED) Green Building Rating System for their newest building project, the Children's Hospital of Pittsburgh (CHP). "LEED is a third-party certification program and the nationally accepted benchmark for the design, construction and operation of high performance green buildings" (U.S. Green Building Council, 2008).

The hopes for the new CHP building are to have an energy efficient and low waste producing building. Specific LEED credits include: the site for the new building is located in a dense, urban area with

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nearby options for alternative transportation methods, the building uses smart systems for controlling room temperature based on occupancy and with individual thermal controls, low emitting materials, such as paints, carpets, and composite wood products, are to be used, and a new paperless policy will be implemented along with improved waste reduction and recycling programs. Many of the steps taken to green the CHP campus are maintained by building occupants. Based on previous attempts at greening their institution, UPMC is aware of the importance of training staff on the using and operating a green building as compared to a conventional building in order to secure the success of the green building.

Occupants of Green Buildings

Research shows the importance that interactions with nature give to human health and productivity, and this is exceptionally relevant for hospitals. Ulrich (1984) studied the recovery time of surgery patients who had views of nature verse those who did not. The patients that viewed trees through their windows recovered sooner and with fewer pain medications than those with windows viewing other buildings. The guidelines for green building are sensitive to the connection that humans have with nature. Many tenets of LEED certification also encourage this interaction of building occupants with nature: daylighting, green roofs, outdoor green space, and community connectivity are just a few examples. Nature has more than health and healing benefits. Green space provides opportunities for socialization with coworkers or provides escape from the stresses and pressure of the workday (Burgess et al., 1988; Kaplan, 1993, 2007).

Similarly, the added benefits of improved health from green buildings lead to fewer sick days. Decreased absenteeism from improved well being, or improved health on its own, also increases productivity. A study done with workers of a Herman Miller manufacturing plant in Michigan (Heerwagen, 2001) showed an increase in productivity of 0.22% in the first nine months after moving from a small manufacturing plant into the new green facility. Productivity at the plant did not experience the normal loss associated with moving. Also, workers reported an increased sense of well being at work and looked forward to being there.

Results from studies into the satisfaction of building occupants based on their thermal comfort in green and conventional buildings vary based on individual preferences, but the occupants of green buildings were more tolerant when they understood how the building was supposed to work and the intentions behind the different designs (Leaman & Bordass, 2007; Paul & Taylor, 2008). Occupants may be influence by place. If the building is identified as green, those occupants who have a connection to environmental issues may feel positive about their place of work or residence if it is a green building (Hidalgo & Hernandez, 2001).

Occupants' Impacts on Green Buildings

The studies described show how nature and healthy indoor environmental quality have positive effects on building occupants and that green buildings may influence the way occupants feel about their workplace/residence, but little research describes the impact of the behaviors practiced by building occupants. Differing technologies between conventional and high performing buildings means differing behaviors between the occupants of each type of building. There is little research that addresses the need for occupants to be trained on how to live or work in compliance with green buildings. One study by the General Services Administration (GSA) (2008) examined 12 of their LEED certified buildings and compared them to conventional buildings with the same use. It was found that overall the 12 sustainable buildings had higher occupant satisfaction than the national average for conventional commercial buildings. A case-by-case evaluation of the specific occupants found lower individual satisfaction due to complaints on poorly calibrated and/or managed mechanical systems. The authors called for the need for good maintenance, which can only come from proper training of staff to handle the novel systems of high performing buildings. In the same study, the GSA noticed that though many buildings they evaluated had programs in place for following green practices, occupants did not comply. They suggested that designers and building owners establish the infrastructure for following and promoting green practices.

Behavior Change

At a basic level, building systems are created with the intention of being used. Therefore, occupants play a vital role in how a high performing building functions, but if systems are designed based on assumptions of how occupants will use the building, steps must be taken to ensure that the building will be used in that manner (Wener & Carmalt, 2006). Occupants make choices all the time that affect the building's footprint. These decisions can be as simple as opening or closing windows and lowering or raising the blinds. Individual comforts vary. Studies of thermal comfort and aesthetics of green buildings compared to conventional buildings found that preferences were very different on a case-by-case basis between buildings (Leaman et al., 2007; Paul et al., 2008). Thus, an efficient heating and cooling system may be installed, but if occupants do not understand how to control the system or feel personal discomfort, they will make changes potentially reducing the efficiency of the system.

Barriers to behavioral change exist. Individuals interpret scientific information differently and within the terms of their personal experiences and beliefs (Irwin & Wynne, 1996). Similarly, perceptions of environmental risk, fear, and guilt vary by the individual's perceived abilities to act and personal attachment to the issue (IPCC, 2007). Attempts to encourage environmental stewardship often come with information about environmental issues and concerns. Though this seems logical, research does not fully support this idea (McKenzie-Mohr & Smith, 1982).

In fact, knowledge alone does not lead to behavior change. Some prior research shows that the traditional model of knowledge leading to action is not necessarily applicable to education about the environment. Hungerford and Volk (1990) found that three categories of variables contribute to behavior change. These categories are entry-level variables, ownership variables, and empowerment variables. Entry-level information includes environmental sensitivity and knowledge of ecology. Ownership variables include in-depth knowledge of an issue, personal investment in the issue, and knowledge of the consequences of negative and positive behavior. Empowerment variables include the knowledge of, the skills to, and the intention to act. The reasoning is that simply telling someone to change his or her behavior will not instill behavior change. One must provide reasoning that supports why the behavior change is better. Similarly, behaviors are made up of a combination of many skills and perfecting each of these skills requires knowledge of how they work, their results, and the reasoning to perform them. Sustainable behavior changes are specifically complex and encompass a number of routines, contexts, and situations (Heimlich & Ardoin, 2008)

In general, individuals are more concerned with how environmental issues affect themselves and others before being concerned with the biosphere (Chau et al., 2005). In order to have occupants perform actions that support the building's impact on the environment, it may be necessary to make their connection to the building evident or provide clues to how their actions impact the building's operations. For example, turning off a computer monitor will provide energy savings. This savings may not personally affect the computer user, but if the savings were passed on to staff or if occupants were rewarded for overall building energy savings, their actions to support the green building would reflect their personal involvement. Therefore, it is important to make it easier for occupants to comply with sustainable behaviors (Wener et al., 2006). Policies should be put in place that allow energy efficient actions, reminders or cues located around the building, and trainings created that encourage and educate on the suggested sustainable actions. But what is the proper amount of training necessary to inspire behavior change determined?

Purpose

Training occupants on sustainable behaviors will provide them with the knowledge of how to support the green building they are working in, but knowledge alone does not lead to behavior change. This research is part of a two-part study to develop quality sustainability training materials. A multi-criteria decision analysis was used to determine a focus for training materials (Steinberg et al., 2009), specifically energy saving behaviors. The purpose of this study is to determine the quantity of information and the type of information necessary to encourage

behavior change. Objectives are to determine what information is needed to inspire a willingness to alter actions and if this willingness would transfer beyond the workplace to home. Also, the success of the training is compared between staff members that are planning to move to a new green building with staff working at a conventional building.

METHODS

Developing the Training

A multi-criteria decision making (MCDM) process was used to minimize the quantity of training topics. MCDM allows an objective evaluation of alternatives using various criteria that respect the needs of the client. Using the LEED criteria and initiatives achieved by CHP as topics for the sustainability training, a decision matrix approach and focus group resulted in energy-saving behaviors as the focus of the training (Steinberg et al., 2009).

Once the focus of the training was determined, it was necessary to gather information for the training. To begin, researchers gathered a list of sustainable behaviors that would reduce the energy used by the new building or support the new technologies used in the building. Sources that describe any number of simple and complex actions that can be taken for energy reduction were considered (Climate Savers Computing Initiative, 2008; Heede, 2002). This list of behaviors was reduced by three considerations: is this action performed often, is the decision to act made by the user, and is the alternative clearly worse? For example, one behavior in the original list was "turn down the brightness setting on your monitor." The first question asked was if this was an action that could be preformed often. The answer was yes, as most staff members use computers daily. Next it was asked if the decision was up to the user. The answer was yes, as most workers have personal computers, so how their personal workstation is set up is up to them. Finally it was asked if the alternative is clearly worse. The alternative to turning down the brightness setting is comparable, as a higher brightness setting would use more energy. Therefore, this behavior was part of our final list. The final list had 12 behaviors.

Results of the focus group (Steinberg et al., 2009) showed that staff wanted statistical information that supported the importance of the different behavior suggestions. Therefore, researchers collected statistics that support each of the behaviors in the final list. Statistics ranged from the energy saved from performing the action to information about the impacts of not doing a specific behavior. Because the impetus for the training was CHP's move to a LEED certified building, information about LEED and green building was included in the training. A brief description of the LEED certification process and a few of the specific actions taken for the CHP building were included. Finally, researchers wanted to provide global environmental information that framed the importance of behaving sustainable and the need for green building. This part of the training first defined sustainability then described natural resources, renewable and non-renewable, and the issues associated with overuse of non-renewable resources. Next, the training briefly defined global warming and climate change and the impacts associated with increasing atmospheric CO_2 and temperature. Solutions to climate change were presented in terms of environmental stewardship and organizational responsibility. Finally, the impacts of the built environment are described along with the ecological, economic, and health benefits of green buildings.

Due to the client's expectations and technical requirements, the training was presented through an online training program. Training information was developed in a PowerPoint presentation and presented to trainees as a series of slides, which are read by the individual at their own pace. The information that was gathered for the training was presented as text and images. Each slide held no more than a few points of information. For the suggested energy-saving behaviors, each behavior and its statistical support information comprised one slide. Following the training was a questionnaire. For each behavior the participant was asked if they were currently doing the suggested behavior, willing to do it, or unlikely to perform the particular behavior. Also, participants were asked to rate their relative agreement or disagreement about the behavior. Using a Likert Scale (Likert, 1932) from 1 to 5, with 1 representing disagree and 5 representing agree, participants stated whether it was worth the effort, whether they had heard of it before, whether they knew how to implement the behavior, whether they thought it would

help the environment, whether they knew how it would help the environment, whether it conflicted with other job requirements, and whether they had the authority to implement it.

Empirical Test of Training

To determine the amount of information necessary to change behavior in the learner, the training was split into varying amounts of information. Each of these trainings represented a different condition. There were 4 conditions in total. Condition 1 served as the control. This group received only the questionnaire without receiving any training. Condition 2 training was a list of the 12 suggested energy-saving behaviors including corresponding statistical information plus the questionnaire. Condition 3 added the information about LEED to the training and condition 4 added the global environmental information. Based on the month of birth, participants were assigned to one of the 4 conditions. Participants were evenly and randomly assigned to conditions, thus it was assumed that there was no difference between respondent populations. Therefore, the control condition serves as a baseline to compare other conditions and assess their intention to act.

The training was distributed to three populations (Table 1). The first group of participants was nursing staff at CHP. A link to an online version of the training was sent out through email to staff from a department supervisor. Participants were offered a $25 visa gift card to participate. The online survey was closed once 150 trainings had been started. Of these 150, 17 did not complete the training, giving a total of 133 respondents. The second group of participants was also comprised of a random group of CHP staff; participants included clinical, administration, and operations staff. Again, the online survey was closed once 150 trainings had been started. Of these, 28 did not complete the training, giving a total of 122 respondents. The final population to take the survey was nursing staff at a different hospital, Magee Hospital, which is also a part of UPMC, but working in a conventional building. Again, a link to an online version of the training was sent out through email to staff from a department supervisor. The only change made to the training was that the section on specific LEED criteria was removed, as this population would not be moving into a new building and their current building is not LEED certified. Participants were again offered a $25 visa gift card to participate. The online survey was closed once 150 trainings had been started. Of these, 21 did not complete the training, giving a total of 129 respondents.

FINDINGS

The first objective of this study asked what information is needed to inspire a willingness to change behaviors in building occupants. The results of the surveys taken by the first set of participants, nurses working at CHP, were used to determine if there is a difference between the experimental and control conditions (Figure 1). Those receiving information about LEED, condition 3, (M = .94, SD = 0.11) were 12% more willing to change behaviors and perform the suggested actions at work than those in the control condition (M = .82, SD = 0.24), $t(150) = 3.85$, $p = .0002$. There was only a marginal difference in willingness to change behaviors between the participants receiving global environmental information, condition 4, (M = .88, SD = 0.20) and the control group, $t(161) = 1.93$, $p = .06$.

TABLE 1. Participant groups and corresponding test conditions.

	Condition 1 (control group)	Condition 2	Condition 3	Condition 4
	Questionnaire	Behaviors + Questionnaire	LEED + Behaviors + Questionnaire	Global information + LEED + Behaviors + Questionnaire
CHP—nurses	✓	✓	✓	✓
CHP—clinical	✓	✓	✓	✓
Magee—nurses	✓	✓		✓

There were no differences between the participants receiving just the list of sustainable actions, condition 2, (M = .86, SD = 0.25) and the control group's willingness to do the suggested actions, $t(165)$ = 1.24, p = .22. This shows that to inspire a willingness to change behaviors, participants required information about green building and the specific actions taken by the new LEED building they would soon be moving into. The combination of specific sustainable behaviors, the statistical impact these behaviors have, and information about how these behaviors align with the green building movement is the quantity and type of information necessary to create a willingness to change behaviors.

The intention of the training was to encourage participants to choose energy-saving behaviors when working in the new LEED certified building. These suggested behaviors are not all exclusive to work situations, but are also relevant, energy-saving behaviors for the home. Organizations must consider the interests of society by taking responsibility for the impact of their activities on patients, suppliers, employees, communities, and other stakeholders, as well as the environment. Therefore, it was important to evaluate whether the training intended for work behaviors transferred to willingness to do these behaviors at home (Figure 1). Again, the results of the surveys taken by the first set of participants, nurses working at CHP, were used. Both the LEED condition (M = .83, SD = 0.25) and the explanations condition (M = .82, SD = 0.24) had significantly higher levels of willingness to do the behaviors at home than the control condition (M = .73, SD = 0.30), $t(146)$ = 2.27, p = .03; $t(156)$ = 2.18, p = .03, respectively). There were marginal differences between the global condition (M = .81, SD = 0.27) and the control group, $t(149)$ = 1.83, p = .07. This shows that training the staff on information about LEED or just presenting the list of sustainable behaviors inspired staff to try these behaviors at home. Again, extensive information about the environment does not inspire a willingness to change in participants.

The second objective of this study compared staff members of a green building with staff working at a conventional building. Our case study looked at two groups moving into a highly publicized green building, while the other participant group worked in an older, conventional building. The participants from the different sites have significantly different levels of willingness to change behavior at work, $F(2,374)$ = 21.79, p < .0001 (Figure 2). Based on the Fisher's PLSD post-hoc test, both groups planning to work at the new CHP green building that were evaluated (M = .91, SD = 0.16; M = .91, SD =

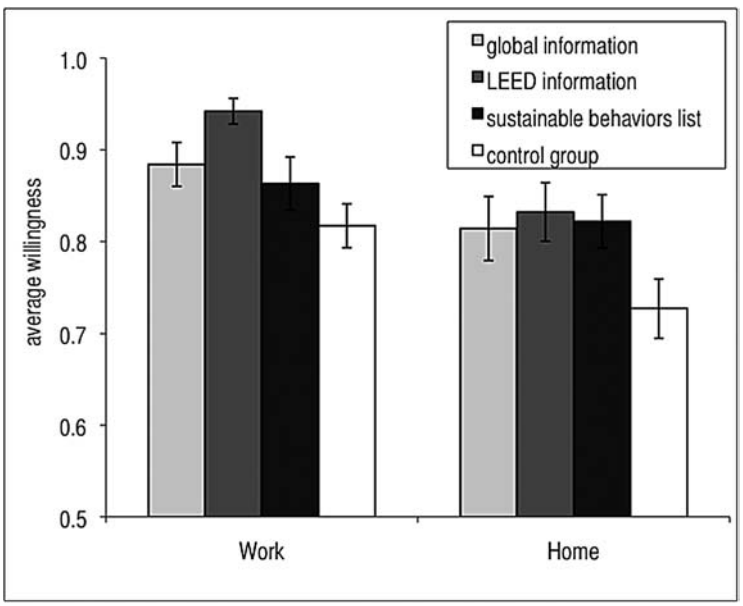

FIGURE 1. Impact of training conditions on willingness to implement each behavior.

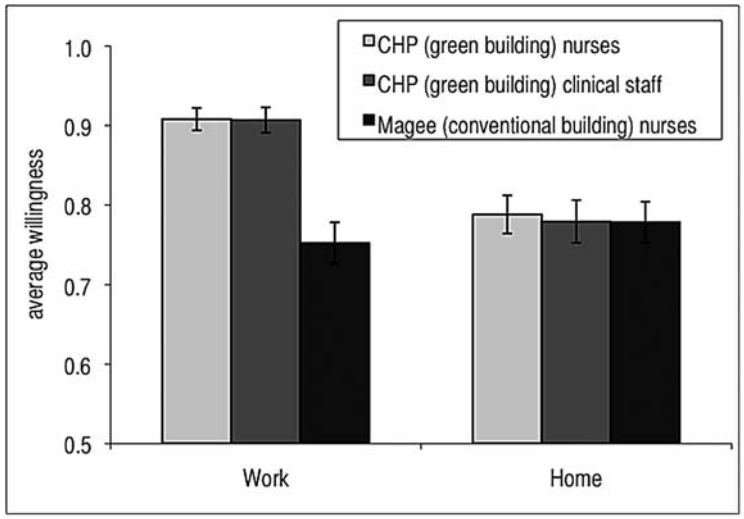

FIGURE 2. Green versus conventional buildings.

0.17, respectively) were more willing to change behaviors than the nursing staff at Magee Hospital's conventional building (M = .75, SD = 0.29). Considering that the LEED information in the training was most significant in inspiring behavior change, it is not surprising that the staff members that are well aware of their move to a LEED certified building would be willing to change behaviors to support their new workplace. This can be attributed to a pride in their place of work. The greening project has been well publicized and is well known. Staff members are possibly inspired by their new green building and want to ensure its success by changing their current behaviors to more sustainable ones.

Again, the willingness to transfer these energy-savings behavior from outside work to home was examined. There were no differences between the sites in levels of willingness to change behaviors at home, $F(2,350)=0.05$, $p=.95$. All three groups were equally inspired by the training to practice the newly learned behaviors at home.

CONCLUSIONS

The willingness of staff to do more energy-saving behaviors increases when information is provided about the reasons for suggesting these behavior changes. In the case of this study, the information that influenced behavior change was knowledge and descriptions of the specific actions that were being taken in their place of work in addition to information about LEED and the actions taken to make their building LEED certified. Also, information about LEED as well as the list of sustainable behaviors had a significant impact on encouraging staff to transfer these behaviors to their homes.

Comparisons made with similar staff working in a conventional building that received the same trainings showed that they did not have this willingness to change behaviors. This can be explained that they were not willing to change behaviors because they did not have the anticipation of moving into a green building. Staff was inspired to act in more sustainable manners due to the knowledge that the building they would be working in is a green building. It was not the knowledge of environmental issues that persuaded them to perform energy-saving behaviors; it was the information about the building they would be occupants of that inspired their stewardship. The success of this training depended on the knowledge of the new building being LEED certified.

This supports the idea that occupants of green buildings can be an important factor of green building certification and success. If staff are trained on how to behave in a high performing building and told how their actions will support the steps taken to be LEED certified, they will be more willing to work in harmony with the new technologies used to create a green building.

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