A SELF-INSTRUCTIONAL MANUAL FOR INSTALLING LOW-COST/NO-COST WEATHERIZATION MATERIALS: EXPERIMENTAL VALIDATION WITH SCOUTS

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In this study, we describe the development and evaluation of a self-instructional program for installing 10 low-cost/no-cost weatherization materials (e.g., weatherstripping, caulking). This program was a weatherization and retrofit manual (WARM) providing step-by-step instructions and illustrations. Boy and Girl Scouts participated and used either the WARM or existing product instructions (EPI) to apply the materials. Scouts installed the materials properly only when they used the WARM.

DESCRIPTORS: energy conservation, self-instruction, adolescents

Energy conservation has been a frequent topic of applied behavioral research in which it has been common to provide combinations of prompts, informational feedback, and monetary incentives that encourage consumers to set back thermostats and turn off lights (Cone & Hayes, 1980; Geller, Winnett, & Everett, 1982; Hayes & Cone, 1981; Luyben, 1980; Winnett, Kagel, Battalio, & Winkler, 1978). Perhaps this research will contribute to a large-scale effort to conserve energy. However, it is limited by the particular nature of the behaviors selected for modification. That is, this research has focused on behaviors that consumers must repeatedly emit (e.g., adjusting the thermostat) to save energy. Accordingly, modification of these behaviors has typically required continuous monitoring of energy consumption and repeated provision of assorted prompts or consequences. The feasibility of this approach is questionable and its long-term effectiveness has been debated. According to a recent estimate adjusting the thermostat may save only about 4% of total household energy consumption (Stern & Gardner, 1981); greater sav-

ings have been attained, however, over short periods (Winnett, Hatcher, Fort, Leckliter, Love, Riley, & Fishback, 1982).

Because of these limitations a complementary program of research has been advocated that would promote alternative energy systems (e.g., solar) and improve existing systems through retrofitting and weatherization (Stern & Gardner, 1981; Winnett, 1980). This approach offers many appealing advantages. For example, materials such as insulation, weatherstripping, and caulking are effective after only a "one-shot" application (Stern & Gardner, 1981). Thus, there is no need for continuous monitoring, prompting, and feedback. Further, insulation and weatherstripping may reduce total household energy consumption by 10%; a greater savings than typically obtained by adjusting the thermostat (Stern & Gardner, 1981).

To encourage wide-scale use of these materials, many obstacles must be overcome. For example, to avoid the expense of professional labor much of the material is intended for application by homeowners themselves or other resource agents in the community. However, these nonprofessionals may need to be taught how to install the material properly.

Behavior analysts can help by designing and evaluating programs for local, state, and national agencies to teach citizens how to weatherize homes.

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We have taken that approach in this study with a self-instructional program that was developed and evaluated on behalf of a local energy resource agency, the Shawnee Solar Project (SSP) of Jackson County, Illinois. The evaluation of this program was undertaken with scout troops whose participation was considered desirable because the SSP attempted to enlist volunteers to assist in community weatherization efforts; the scouts' philosophy is based on rendering service to the community; and scouts' participation enabled them to learn, at an early age, to conserve energy.

METHOD

The Sponsoring Agency

The SSP provided residents with information and technical assistance for conserving energy. Its interest in developing a self-instructional program was based on an experience 1 year prior to the study in which 1,874 residents attended workshops sponsored by SSP through a grant awarded by the U.S. Department of Energy (cf. Geller, 1981). During these workshops, SSP staff demonstrated the installation of low-cost/no-cost weatherization materials (e.g., weatherstripping, caulking) and gave a participant from each household approximately \$75 of these materials. However, weeks later, interviews with a sample ($N = 33$) of participants and on-site inspection of their homes revealed that much of the material had not been installed properly. Participants often reported that the instructions accompanying the materials were poorly written and illustrated and they failed to specify the tools to use or where to apply the material. Based on these results SSP decided to develop a self-instructional program for homeowners or volunteer agents to use in weatherizing homes.

Participants

Twenty-six Boy Scouts, ages 9–16 ($M = 12.9$) and 14 Girl Scouts, ages 12–17 ($M = 13.2$) participated. They represented three of eight Boy Scout and two of three Girl Scout troops located in two small Midwestern towns (Carbondale and Mur-

physboro, Illinois). All 11 scout troop leaders were approached and invited to participate in this study. Five of the eight Boy Scout troop leaders and one of the three Girl Scout leaders declined.

One exceptional Girl Scout, age 15, was enrolled in a special education class (diagnosis not available) and had approximately a second- or third-grade reading ability, according to her scout leader.

Because scouts typically worked in self-selected pairs (the buddy system) when undertaking hands-on projects, the experimenters agreed to accommodate this system in designing the study.

Settings

The weatherization materials were installed in low-income households (i.e., with earnings of \$0 to \$4,737 per year for one person; \$4,738 to \$6,326 for two people). These homeowners were identified (and subsequently contacted) in one of three ways: (a) by the scouts' leaders who knew such homeowners, (b) by the experimenters who knew of such homeowners, and (c) by SSP which maintained a list of qualified homeowners.

Materials

Hardware. Table 1 lists the products used in the study. These were the same products used in SSP workshops a year earlier and were recommended by SSP because of the quick return (in terms of reduced energy bills) on their cost and because they were readily available at retail outlets.

Existing product instructions (EPI). Table 1 also lists the existing product instructions used in the study. These were usually provided by the manufacturer of the product. However, there were no instructions for tape. In this case, the experimenter told the scouts to find a place where air could leak in that would be appropriate to seal with tape.

Development of the weatherization and retrofit manual (WARM). The development of the WARM involved a continuous process of testing, revising, and retesting the instructions and illustrations. Initially, we developed a task analysis of the steps involved in installing each material by re-

Table 1
Low Cost–No Cost Weatherization Applications, Product Descriptions, and Source of EPI*

Weatherization applications	Product/source of EPI
Taping cracks in window glass and/or seams in heating/cooling duct systems	Duct Tape/Tuck Tape, Inc.
Using rope caulk	Caulking Cord/Mortell
Adjusting the thermostat on an electric hot water heater	None/Owner's manual, Sears Powermiser
Installing a draft sealer behind electrical outlets or light switch plates	Wall outlet sealers/Enermax
Installing a flow restrictor in a shower head or faucet	Brass disc/Central Illinois Public Service Co.
Installing a door sweep (screwed-on type)	Half aluminum; half vinyl/Sears Sweepseal
Using a caulking gun	Acrylic latex caulk/MD Inc.
Installing hot water heater insulation jacket	Fiberglass insulation jacket/RSA Wrapitup
Weatherstripping a door	Half aluminum; half vinyl/General Window Product Flexotite
Making and installing a plastic storm window	Paper substituted for plastic/Frost King

* Arranged from least to most difficult. Rank-ordering was completed by the SSP staff.

peatedly observing an energy expert (SSP staff member) install the materials. These task analyses were written as a set of simple step-by-step instructions for completing each application. Key steps in the installation procedure were illustrated by a professional artist, Pat Peterson. Subsequently, SSP staff reviewed the instructions and illustrations and changes were made based on their recommendations. Finally, the WARM was field-tested with a variety of populations including senior citizens, undergraduate college females, graduate students (male and female), and Boy and Girl Scouts (not included in this study). Based on these field-test performances additional revisions were made. (The WARM and the rating scales are available at cost from the second author.)

Dependent measures. The variable of interest was the quality of each of the scouts' installation of either the WARM or EPI. Therefore, a system was devised for rating the quality of each application on a 6-point scale: not attempted (0), totally unacceptable (1), less than average (2), minimally acceptable (3), above average (4), superior (5). Each point on the scale corresponded to a set of defined attributes specific to each installation. In developing this scale, the attributes of each application were incorporated into a matrix. Thus, the matrix cells represented all possible combinations

of attributes that could define a particular installation. A sample matrix for installing draft sealers is presented in Table 2. The relevant attributes are identified around the borders of the matrix. They pertain to whether the electrical plate is flush to the wall (to prevent air leaks), whether it is straight, and whether the sealer is visible (not thoroughly covered by the plate). To use the matrix, the question pertaining to each attribute is asked in the sequence that it is lettered (A, B, C). For example, the yes-no answer to "Is the electrical plate flush?" limits entry into the matrix down two of four possible columns of ratings. Their intersection with the cells corresponding to the answer to the next question ("Is sealer visible?") further limits the

Table 2
Matrix Representing the Relevant Combinations of Attributes and Their Associated Outcome Ratings for the Installation of a Draft Sealer

		A. Is electrical plate flush to wall?			
		Yes		No	
B. Is sealer visible?	No	5	4	2	2
	Yes	4	3	2	1
		Yes	No	Yes	No
		C. Is electrical plate straight (perpendicular to floor)?			

possible ratings to two; their intersection with the last question's answer produces a final rating for the particular installation. SSP staff specified the ratings that were appropriate for each combination of attributes (i.e., matrix cell).

Design

We compared the quality of scouts' installation of WARM versus EPI. Specifically, SSP staff divided the 10 applications into two sets (A and B), roughly matched for difficulty. When the scouts arrived (in pairs according to the buddy system) at a house, the experimenter randomly assigned one to attempt Set A, while the buddy attempted Set B. Scout 1 began Set A using WARM and proceeded through the installations alternating between WARM and EPI. The buddy proceeded through Set B alternating between EPI and WARM. At the next household, the next pair of scouts also completed Sets A and B. However, the order in which they alternated use of EPI and WARM was counterbalanced with respect to the order followed by the first pair. Finally, the design included a retraining stipulation such that any application completed at or below minimally acceptable (rating of 3 or less) using one set of instructions, would be reattempted by the scout using the other set of instructions.

Experimental Procedures

The experimenter provided all necessary hardware and materials from which scouts were free to select. Each scout was given his or her respective set of instructions and asked to complete the specified installations. No other help was given. Due to limited materials, the applications of tube and rope caulk were restricted to a bead 30.5×61.0 cm. In addition, storm windows, normally constructed from plastic cut from large sheets ($1 \text{ m} \times 1 \text{ m}$), were instead constructed from white tablecloth paper ($1 \text{ m} \times 1 \text{ m}$). Finally, the adjustment of the hot water heater thermostat was always attempted on a small electric heater that the experimenter brought to the household.

The parents of the Girl Scout in the special education class imposed strict time limits on her

participation. Because of this and her reading difficulty, the experimenter read aloud the WARM instructions (one step at a time). EPI was not used with this scout.

Reliability

Two observers (graduate students) independently rated 50% of each type of installation attempted with each set of instructions. The percentage of agreement on ratings (where an agreement required the exact same rating) was 99.4%.

RESULTS

Table 3 presents the mean rating (across Boy and Girl Scouts because no significant difference existed) for each installation and the percentage of scouts who completed each at or above acceptable levels (i.e., rating of 3 or better). Most installations that most scouts attempted with the EPI were rated as less than acceptable (i.e., less than 3). In contrast, with the WARM instructions, scouts completed all installations well above minimally acceptable levels.

Scouts who initially could not acceptably complete installations using EPI, reattempted them using the WARM. In all cases these subsequent attempts received ratings above acceptable levels. No scout who initially attempted an installation using WARM required retraining.

DISCUSSION

The apparent shortcomings in the quality of instruction for installing weatherization materials may not be limited to EPI. In subsequent but limited tests, commercially available "how-to" publications (e.g., from Sunset catalogues) were no better in teaching scouts to apply these materials. Social validation questionnaires showed that scouts preferred the WARM over EPI and commercial publications.

There were practical limitations of this study. For example, it is unclear whether scouts, if given unlimited time and opportunity, could satisfacto-

Table 3

Mean Outcome Ratings and Percentage of Scouts Completing Each of Ten Low-Cost/No-Cost Weatherization Installations Acceptably (Rating of 3 or Better)

Application	Participants (N)		M rating		% scoring 3 or above	
	WARM	EPI	WARM	EPI	WARM	EPI
Set A						
Taping	10	10	5.0	3.0	100	70
Thermostat adjust.	10	10	5.0	2.3	100	50
Flow restrictor	10	10	5.0	1.3	100	30
Tube caulking	10	10	4.6	1.6	100	40
Weatherstrip	10	9 ^a	4.6	0.0	100	0
Set B						
Rope caulking	10	9 ^b	5.0	3.1	100	78
Draft sealers	10	9 ^b	4.7	3.6	100	78
Door sweep	10	9 ^b	4.8	0.1	100	0
Hot water jacket	8	7 ^{b,c}	5.0	0.6	100	0
Storm window	10	9 ^b	4.9	1.7	100	22

^a N is less than 10 because one modular home could not be weatherstripped.

^b N is less than 10 because the special ed. scout did not use EPI.

^c N is less than 10 because hot water jackets were already installed in three homes.

rily install all materials regardless of the instructions. It is also unclear whether the observer's presence (which was required by parents) affected scouts' performance. Nonetheless, the effort to conserve energy should benefit from behavioral research that promotes the use of weatherization and retrofit devices. It should also benefit from research that recognizes the importance of teaching children and adolescents to conserve energy (Yeaton, Greene, & Bailey, 1981). In these respects, this study offers some merit in broadening applied behavior research in energy conservation.

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