

FIRE PREVENTION AND SAFETY GRANT PROGRAM
Project Number AA-5-14896
FINAL REPORT

By

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Executive Summary: Volunteer Firefighters from the States of Pennsylvania, Alabama, Indiana, New Mexico and Oregon were sent pre-tests of firefighter technical knowledge and firefighter attitudes toward health and safety. Each state was sent invitations to participate on the Internet. When 150 self-selected participants from each state returned agreements to participate, they were randomly assigned to treatment and control groups. Both groups were sent a multiple choice pre-test of technical firefighter knowledge and attitudes. As soon as the treatment group participants returned their completed pre-tests, they were sent a copy of *Fire Department Safety Officer*, along with an accompanying study guide, with instructions to complete the study guide in four weeks. Both books contained technical descriptions of firefighter health and safety. Six weeks after the books were mailed to participants, they were mailed a post-test composed of essentially the same questions in scrambled order. Pre-tests and post-tests were then compared using T-Test of means of dependent samples to measure gains of the treatment groups and T-Test of means of independent samples to compare post-test scores of treatment and control groups. When all five states were grouped together the analysis showed gains in technical knowledge between treatment and control groups, but not in attitudes. When taken separately by state, only Pennsylvania and Indiana showed gains in knowledge, while the other three states did not show significant gains. However, when all states were combined to give a national picture, the gains in technical knowledge were significant ($p \leq .05$) Researchers concluded that self study was an effective way to improve volunteer firefighter knowledge of health and safety.

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Beginning date: April 23, 2006 – ending date: Dec. 13, 2007

Project title: “Firefighter Safety Research and Development: Determining the Effectiveness of Self-instruction as an Educational Method to Impact Firefighter Health and Safety”

Introduction

This research project was conducted by Fire Protection Publications and the School of Educational Studies of Oklahoma State University under a grant from the United States Fire Administration/FEMA. The purpose of the research was to investigate one of the educational methodologies that might have promise as a method of reducing firefighter injuries and fatalities. In cooperation with the National Volunteer Firefighter Council, the research was designed to help meet the National Fallen Firefighter Foundation’s Firefighter Life Safety Initiatives (Everyone Goes Home, 2007).

Our research interest was to investigate what can be accomplished to change both the culture of volunteer firefighters, their knowledge of health and safety and their attitudes toward risk-taking. Some have argued that health and safety has traditionally focused on possible harms rather than on the culture of safety in which possible risks are framed (Dake, 1992). Also, it is common knowledge that risky behavior is inversely related to the level of knowledge (Sjoberg, Drottz & Britt., 1991; Simonet and Wilde, 1997). For these reasons this research project called for a research design to see if volunteer firefighters would engage in self-directed learning, if they were provided with all the knowledge resources with the promise of a small incentive.

Need for the Research

Although the firefighter fatality rate of 171, recorded in 1978 (<http://www.usfa.dha.gov/about/media/2002releases/02-00t.shtm>) has been reduced due to better firefighting equipment and improved training and guidelines, yet an average of 106 firefighters have perished while in the line of duty each year from 1995 to 2004.* Many of those fatalities were preventable, had those firefighters followed the guidelines published in the NFPA 1500 Standards on Fire Department Occupational Safety and Health Program (2002).

Although the fatality statistics given above involve all firefighters, this study focused exclusively on volunteer firefighter health and safety, excluding [career](#) firefighters. Why volunteer firefighters? In the first eight months of 2006, 55.8% of all firefighter fatalities have been among volunteer firefighters (<http://www.usfa.dhs.gov/downloads/txt/06-fatality-summary.txt>). For fatalities due to sudden cardiac arrest, the percent is even higher as a summary of firefighter fatalities from 1995 to 2004 indicate (Fahy & LeBlanc, 2006). This study also addressed the recommendations of Firefighter Life Safety Initiatives (Everyone Goes Home, 2007) whose sixteen life safety initiatives included # 1 a need for cultural change among firefighters; # 2 a need for more accountability; # 4 the national need to enable firefighters to stop unsafe practices; and # 7 the recommendation to "...create a national research agenda..." on firefighter life safety strategies.

Theoretical Model used in the Research

First, let us examine the construct of self-directed learning. Where and when did this concept arise? Although human beings have probably always engaged in self-

directed learning, research into the theory began with the work of Allen Tough (1967, 1971) on self-instruction. Early research on self-instruction, or as Knowles (1970) later coined the term, self-directed learning, was purely descriptive. Following those descriptive studies, the research became more analytic (Brockett & Hiemstra, 1991; Candy, 1991; Garrison, 1997).

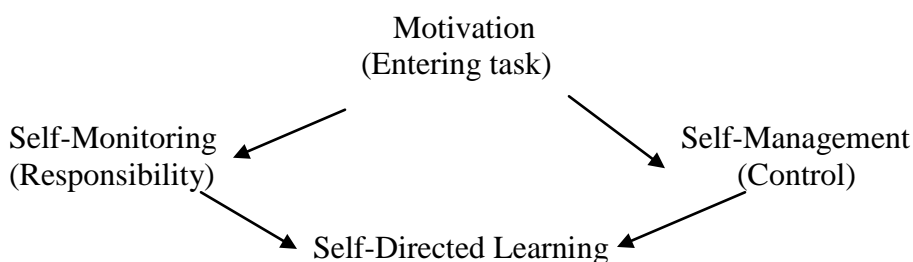
According to adult learning theory, individuals engage in self-directed learning (henceforth, SDL) in order to achieve practical goals that they can apply immediately to their lives. In addition, SDL theory maintains that adults engage in SDL when the content of their learning relates closely to what is important at a given time in their lives. Following the SDL theoretical framework, the National Health and Safety Assessment Project is intended to help volunteer firefighters reduce the level of injuries and fatalities related to their work.

This project proposed to determine whether self-directed learning can be carried out on a national scale by creating a test that would diagnose the learning needs of volunteer firefighters. Once diagnosed, the study aims to provide learning goals identified by the National Fire Protection Association (NFPA, 2002) and to provide the material sources for learning. Rather than have the volunteer firefighters evaluate their own learning, a commonly accepted practice in self-directed learning, this research adhered to the empirical canon of objective measures obtained by an external evaluation by means of a post-test.

Garrison (1997) maintained that self-directed learning has three important components. These components provide the theoretical frame for our study. According to Garrison, SDL requires self-management on the part of the adult learner. At the same

time SDL requires motivation, and finally self-assessment. We assumed for this study that our participants would have various degrees of self-management and self-monitoring. As for motivation, we assumed that all volunteer participants would be highly motivated, not necessarily by the promised materials, but by the fact that health and safety would be a central issue in their lives as volunteer firefighters. Below is an illustration of the components of SDL and a discussion of how those components fit into the decision to participate and the successful completion of a self-study project. (See Figure 1). We selected this model with the full awareness of all the demands placed on volunteer firefighters' time, knowing that nearly all of them work full time and have family obligations. We thought Garrison's model fit this research better than other models and theories of SDL because, due to their time limitations, volunteer firefighters would have to carefully monitor their time and their obligations to be able to finish the study.

Figure 1. Garrison's Dimensions of Self-Directed Learning

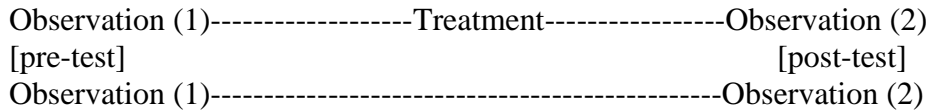


Adapted with permission from Garrison, R. (1997). Self-directed learning: Toward a comprehensive model. *Adult Education Quarterly*, 48 (1), pp. 18 – 33.

This research study used a pre-test/post test design, with random assignment to treatment and control. The pre-test, as well as the post test assessed the knowledge and

attitudes of the volunteer firefighters who volunteered to participate in the study. Figure 2 illustrates the method used in this study.

Figure 2. Method used in This Study



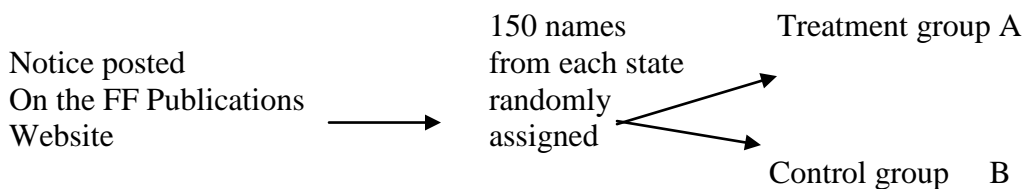
Population and Sample

Volunteer participants were recruited by means of an announcement posted on the official website of Fire Protection Publications located at Oklahoma State University. The invitation was posted on a nationally recognized website; however, it specified that the invitation was open exclusively to volunteer firefighters from Pennsylvania, Alabama, Indiana, New Mexico and Oregon. Invitations were also sent to the training centers in each of these states and to the Fire Marshals of these states. Interested firefighters from each of these states were asked to submit names, addresses, company, and email address. Once 150 names and addresses were received, the names were printed on slips of paper and put into a hat. They were then mixed thoroughly and drawn one by one, assigning the first slip of paper to treatment and the second to control until all 150 had been drawn and assigned (see Figure 3). Those particular states were chosen to represent the Southeast, East, Midwest, Mountain and Pacific Regions of the United States in an effort to gather a sample that, although not random and strictly representative, could claim to reflect the entire United States rather than any one region of the country.

The initial response to the website was very encouraging—529 individual volunteer firefighters from only two states responded to the first invitation posted on the

website. Included with some of the responses were comments written in a dialog box such as, “I look forward to participating in this survey.” and “This is a great idea.” Of those volunteer firefighters who responded to the invitation, the first 150 from Pennsylvania and the first 150 from Indiana were then randomly assigned to treatment and control groups (See Figure 3).

Figure 3. Method of Selecting Participants



Data Collection Instrument

The first step in the project was to develop an assessment instrument designed to measure the knowledge and attitude levels for the sample of volunteer firefighters selected from the five states listed above. The assessment instrument was constructed from the literature and firefighter websites that track incidents of death and injury. The assessment instrument was pilot tested on two different groups of volunteer firefighters. The first pilot test was conducted in September, 2006, in which we analyzed the responses of 62 volunteer firefighters from Oklahoma. Reliability coefficients for the first pilot study were unacceptable-- .87 for Part II of the instrument and .279 for Part I. Hence the instrument was thoroughly revised, using statistical item analysis that revealed the poor items. For the second edition of the instrument we dropped many items, added new ones, transferred items from Part I to Part II, and reduced the instrument from 63 items to 60. For the second pilot test, we sent the instrument to three companies in New Jersey.

Thirty-two completed instruments were returned of the 50 sent out. The second pilot test resulted in Alpha coefficients of .853 for Part I and .896 for Part II. Reliability coefficients improved to .866 for Part I and .862 for Part II, using the Spearman Brown correction formula on a test of split half reliability. After the two pilot tests, we considered the instrument sufficiently valid and reliable to conduct our data collection.

Initial survey instruments (the pre-test) were printed and mailed to the list of volunteers from Indiana and Pennsylvania beginning June, 2007. Alabama surveys were mailed in July and Oregon and New Mexico surveys were mailed in September and October. Both groups A and B of each state received their surveys at approximately the same time. Upon reception of a completed pre-test survey from a given participant of group A (experimental group) of each state, two self-study materials were mailed first class. The materials included Stowell, Brakhage & Smith, (2001) *Fire Department Safety Officer* and Joerschke & Adams (2001) *Study Guide for Fire Department Safety Officer*. The experimental group was asked to read the book and complete the questions in the study guide in four weeks. Six weeks later they were sent a second survey (post-test) with instructions to complete it and return it in a self-addressed, postage-paid envelope. The same procedure was repeated with Alabama, New Mexico and Oregon some weeks later.

As stated above, both A (experimental) and B (control) groups received their respective second surveys (post-tests) at approximately the same time—six weeks after the initial surveys were returned. Content of the two surveys was essentially the same. However, in the place of the demographic questions, five questions were added, two of which were open-ended. One of the five questions inquired whether future study materials should be on-line or printed; another asked about formats for future training.

The most important of the added items for this study was the open-ended question about the impact of the surveys and study materials. This question was analyzed in a constant comparative method sometimes used for interviews and other types of qualitative data.

Results

As detailed above, each state was mailed 150 survey forms, 75 randomly assigned to what we called group A and 75 to group B. At each of the two mailings there occurred what researchers call experimental mortality. That is, not all 75 volunteers actually completed and returned the surveys. These return rates are illustrated in Tables 1, 2, 3 & 4.

Table 1

Response rates for the pre-test from Pennsylvania and Indiana

PENNSYLVANIA		INDIANA	
From experimental	From control	From experimental	From control
56 out of 75 = 74%	45 out of 75 = 60%	56 out of 75 = 74%	50 out of 75 = 67%

Table 2

Response rates for the post-test from Pennsylvania and Indiana

PENNSYLVANIA		INDIANA	
From experimental	From control	From experimental	From control
42 out of 56 = 75%	33 out of 45 = 73%	43 out of 56 = 76%	42 out of 50 = 84%

Table 3

Response rates for the pre-test from New Mexico and Oregon

NEW MEXICO		OREGON	
From experimental	From Control	From experimental	From control
18 out of 43 = 42%	21 out of 43 = 49%	20 out of 34 = 58%	25 out of 33 = 76%

Table 4
Response rates for the post-test from New Mexico and Oregon

NEW MEXICO		OREGON	
From experimental	From Control	From experimental	From control
11 out of 18 = 61%	19 out of 21 = 90%	15 out of 20 = 75%	14 out of 25 = 56%

Table 5
Response rates for the pre & post-tests for Alabama

ALABAMA PRE-TEST		ALABAMA POST-TEST	
From experimental	From control	From experimental	From control
48 out of 72 = 66%	41 out of 73 = 56%	27 out of 48 = 56%	30 out of 41 = 73%

It is interesting to note that Pennsylvania and Indiana had the highest response rates at the initial invitation and had higher response rates at each of the succeeding mailings. The first step in Garrison's (1997) theoretical model of self-directed learning perhaps explains why the initial response to the invitation on the website was very good. The next two stages of Self-Monitoring and Self-Management may explain why the response rates decreased at each of the two mailings. Reminders were sent out both electronically and by postal service to the selected state training centers and to the respective State Fire Marshal of each state.

The post-test responses between the experimental and the control groups were analyzed using a simple T-test of the means between independent samples. Table 6 shows the descriptive statistics of the post-test scores. Group A is the treatment group, group B the control.

Table 6. Post-test Scores of Treatment and Control for Alabama for attitude & content

	GROUP	N	Mean	Std. Deviation	Std. Error Mean
SumATT	A	24	133.09	18.981	3.958
	B	28	127.93	16.669	3.150
SumCon	A	24	22.50	4.263	.870
	B	28	22.32	1.847	.349

Table 7. T-test of Means between Treatment and Control Groups for Alabama

	T	Df	Sig.(2tailed)	Mean difference	Std. error Difference
Attitude equal variances assumed	1.033	49	.307	5.158	4.993
Content equal variances assumed	.445	46	.659	.390	.876

Sig. \leq .05

At the $P \leq .05$ level, there was no difference between the experimental group and the control group on the post test, neither in the knowledge of firefighter safety and health, nor of the attitudes toward firefighter safety and health. In the Tables that follow SumAtt stands for the attitudinal scores and the SumCon stands for knowledge of content.

Table 8. Comparison of Post-test Scores for Treatment and Control for Indiana

	GROUP	N	Mean	Std. Deviation	Std. Error Mean
SumCont Control	A	43	23.35	2.871	.383
	B	42	21.95	2.515	.443
SumAtt Control	A	39	125.8462	19.40230	3.10686
	B	38	132.0263	11.39580	1.84864

Table 9. T-test of means between Experimental and Control Groups for Indiana

Content equal variances assumed	T 2.304	df 81	Sig.(2-tailed) .024*	Mean difference 1.356	Std. Error difference .589
Attitude equal variances assumed	-1.699	75	.094	-6.180	3.638

*Sig. \leq .05

Table 9 displays the T values and the significance of the knowledge scores of the Indiana group. There was a difference between experimental and control groups on the post-test scores of knowledge alone. Our analysis showed a significant gain in knowledge. The attitude scores showed no statistical difference

Table 10. Comparison of Post-test Scores of Treatment and Control for New Mexico

	Group	N	Mean	Std. Deviation	Std. Error mean
SumCont	A	11	22.18	2.892	.872
Control	B	19	20.47	3.657	.839
SumAttitude	A	11	130.2	20.9	6.609
Control	B	19	132.58	18.65	4.277

Table 11. T-test of Post-Test Mean Scores between Experimental and Control Groups for New Mexico

Content equal variances assumed	T 1.205	df 24	Sig.(2-tailed) .240	Mean difference 1.74	Std. Error difference 1.44
Attitude equal variances assumed	-.313	24	.756	-2.378	7.589

Sig. \leq .05

Using the T-Test of means between independent samples, there was no difference between treatment and control groups in New Mexico. The difference in mean scores might have been related to the very small N from that state.

Table 12. Comparison of Post-test Scores of Treatment and Control for Oregon

	Group	N	Mean	Std. Deviation	Std. Error Mean
SumAttitude	1	15	138.066	11.937	3.082
	2	13	135.538	16.591	4.601
SumContent	1	14	3.134	3.134	.837
	2	12	2.516	2.516	.726

Table 13. T-test of Means between the post-test scores of Experimental and Control Groups for Oregon

Attitude equal variances assumed	T	df	Sig.(2-tailed)	Mean difference	Std. Error Difference
Attitude equal variances assumed	.467	26	.644	2.528	5.409
Content Equal variances Assumed	1.794	26	.085	2.023	1.128

Sig. \leq .05

Table 13 illustrates the statistical analysis between the mean scores on the post-tests of the experimental group and the control group in Oregon. The analysis demonstrates that there was no real difference between the groups. Perhaps because of the low N, the mean difference on mean scores was so small as to be statistically insignificant.

Table 14. Comparison of Post-test Scores of Experimental and Control for Pennsylvania

	Group	N	Mean	Std. Deviation	Std. Error Mean
Sum Content	1	41	23.170	2.178	.340
Control	2	31	21.419	3.528	.6337
Sum Attitude	1	39	129.179	18.929	3.031
Control	2	32	133.000	15.355	2.714

Table 15. T-test of Means between Experimental and Control Groups for Pennsylvania

	T	df	Sig.(2-tailed)	Mean difference	Std. Error difference
Sum Content equal variances assumed	2.594	70	.012*	1.751	.675
Sum Attitude equal variances assumed	-.920	69	.361	-3.820	4.153

*Sig. \leq .05

Tables 14 and 15 comparing the post-test scores of the experimental and control groups in Pennsylvania demonstrates a gain of the knowledge scores, but not the attitudinal scores. The T-test of the difference of the means between the treatment and the control samples of the survey indicate that not much change occurred in terms of attitude, when the quantitative measures alone are considered. However, Indiana and Pennsylvania, had relatively high response rates and improved significantly in knowledge of firefighter health and safety.

It may have been that the long drawn out process of using the postal service and mailing the survey forms at irregular intervals affected the response rates and the motivation of the participants in states with smaller populations. For example, soon after the website invitation was posted survey tests were mailed out to Pennsylvania and Indiana concurrently. Both states had relatively high response rates, as did the Alabama sample. Alabama also received their pre-test surveys soon after the recruitment period. A

alternate hypothesis would suggest that the state population differentials came into play both in terms of response rates and increased scores on the surveys. New Mexico and Oregon are relatively less populated states. High response rates increased the degrees of freedom in the statistical analysis used in this study. The high degrees of freedom could have skewed the analysis. For example, Oregon showed an average mean of 2 points gain in content knowledge (Table 13), a number that was comparatively high. However, both the fewer degrees of freedom and the large error term obviated any significant gain. Indeed the comments to the open-ended questions on the post-test indicated positive changes in knowledge and attitudes.

Finally, we combined the post-test scores of all five states to attempt to gain a national picture of the effect of a self-directed study project on post-test scores of knowledge of firefighter health and safety. To insure that our control and experimental samples were comparable in their knowledge and attitudes of firefighter health and safety, we compared experimental and control groups of all five states combined on their pre-test scores. See Tables 16 and 17 for this comparison.

Table 16. Comparison of Pre-Test Mean Scores of all Five States

Pretest/post-test scores	Group	N	Mean	Std. Deviation	Std. Error Mean
Pre-test Content	1	203	21.134	2.456	.17235
Control	2	186	21.197	3.854	.20932
Post-test Content	1	136	22.963	2.899	.24861
Control	2	135	21.518	2.999	.25817

The reduction in Ns is a measure of the successive experimental mortality combining return rates from the pre-test and post-test.

Table 17. Comparison of Pre-Test Mean Scores of all Five States in Row 1 with Post-Test Mean Scores of all Five States in Row 2 Between Experimental and Control Groups

Comparison of Pre-test Mean Scores between Experimental and Control Groups (Independent Samples T-Test)	T	df	Sig.(2-tailed)
Comparison of Pre-test Mean Scores between Experimental and Control Groups (Independent Samples T-Test)	-233	387	.817
Comparison of Post-Test Mean Scores between Experimental and Control Groups (Independent Samples T-Test)	-4.031	269	.0001*

*P \leq .05

Analyzing our post-test scores between the treatment samples and the control samples in all five states, using the T-Test of means between independent samples we found that the self study project was an effective procedure for enhancing the knowledge of firefighter health and safety, at least among those firefighters who persevered in this relatively long drawn out quasi-experimental study. There were many reasons why firefighters might have dropped out of the study before its completion. We might surmise that the third step in Garrison's model—ability to control one's time was the main reason for non-completion of the self-directed study and testing.

As with many quantitative studies, reliance on a small slice of qualitative data that is added to the study occasionally fills out the picture. Changes in attitude, for example, that showed no statistical improvement in the quantitative analysis seem to have an influence if we were to take into account the small percent of the respondents who answered the open-ended question about the impact of the study. From the wording of the comments, that small percent of the respondents possibly represented volunteer firefighters with

oversight responsibilities. The qualitative data gathered from second open-ended question on the surveys was analyzed into three categories as displayed below.

Open-ended Comments to Question 2: “Please describe any impact that participation in this research project has had on you or your fire department.”

Although there were a variety of answers to the above statement, three themes seemed to emerge from the open-ended questions. All three themes emerged from categories that the research team deemed to be saturated, because they kept appearing on open-ended questions of many returns from the five states. What seemed to be the dominant theme was what we coded as *the awareness for the need to improve safety*. This theme is exemplified by the following statements:

- “This project has brought to light several issues on safety that we do not spend much time on while training.”
- “This has made me realize we have work to do to improve our fire department.”
- “The study has really made me think more closely about our operations on the fireground and station and realize that we’re not as safe as we all thought.”
- “It made me more aware of how to properly avoid any type of safety issues in the future.”
- “I realized how important a safety officer is and how my department is in need of one.”
- “This has been very instrumental in raising awareness.”
- “It has made me realize the need to implement more of a physical fitness program.”
- “This research project made me more aware of the safety officer’s responsibility.”

A second theme we coded as *implementation of health and safety knowledge*. The following quotes are examples of this theme.

- “We are ramping up the training and safety programs in our department.”

- “We have used the course as a review of our departments [sic] SOP’s [standard operating procedures] and firefighter health and safety.”
- “We have used this evaluation to begin round-table discussions among all members.”
- “My department has developed several SOP’s and SOG’s [standard operating guidelines] from questions I answered on this survey.”
- “I promote seatbelt use stronger. I focus [sic] training myself and others better.”
- “We have looked at and are progressing upon the implementation of a risk analysis/management program.”
- “It did get us to get at our SOP and go over a few issues we had.”
- “After completing the safety officer book, I had opened up several conversations with members of my fire department regarding safety.”
- “My department has now added the position of safety officer.”
- “We are in the process of updating our SOP’s.”

Finally, the only other theme that seemed to reach saturation and be important enough to report was the *plan to implement changes sometime in the future*. The following quotes support this theme.

- “...we will work to improve based on this information.”
- “We are trying to implement a health and safety program.”
- “I am currently reviewing my departments [sic] SOG and we are planning on beginning semi-annual firefighter proficiency evaluations.”
- “Will review SOP/SOG’s and bylaws.”
- “I will be addressing these (safety) issues in the upcoming months during training.”
- “I’m...going to give the chief the book to read, this could help improve the department.”

Conclusion

When taken as a national sample, the combined five states we had selected benefited from the self-study activities we invited them to engage in. Their post-tests of technical knowledge related to health and safety showed an improvement, and that improvement was not due to history or chance. On the other hand, there was no improvement in attitudes as indicated by comparing the pre-tests with the post-tests by individual states. The open-ended statements made by a small segment of the participants indicated that there were some volunteer firefighters who had gained heightened awareness and intended to make changes in their modus operandi.

There were limitations to the study. The most glaring limitation was the low return rate, especially at the post-test stage of the project. Due to the limitations of manpower, the survey tests had to be sent out in waves that stretched over four months. A better strategy would have been to send all 750 pre-tests on the same date. Both Indiana and Pennsylvania showed significant improvement on the test of knowledge. These states also had the highest return rates.

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