# LEARNING & RETENTION OF CHEMICAL SAFETY TRAINING INFORMATION: A COMPARISON OF CLASSROOM VERSUS COMPUTER-BASED FORMATS ON A COLLEGE CAMPUS

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## Introduction

Employee safety training is a key part of any organization's overall occupational safety and health program and is mandated by a number of federal agencies, including the Occupational Safety and Health Administration (OSHA). Many resources are available to the safety professional when putting together a safety training course or program. [1, 2, 3] A synthesis of the approaches suggests the developmental process shown in Figure 1. As is shown, the developmental process is highly interconnected. For example, the establishment of training goals and objectives (Step 1) is very much dependent on an accurate evaluation of the learner (Step 2). Conversely, characteristics of the learner may drive the need to modify the desired goals and objectives. Also shown is how applying lessons learned (Step 6) impacts goals and objectives (Step 1), content (Step 3) and delivery method (Step 4).

In order to truly evaluate the effectiveness of any safety training intervention, consideration of each step in the process must be done both during course development and after training is complete.

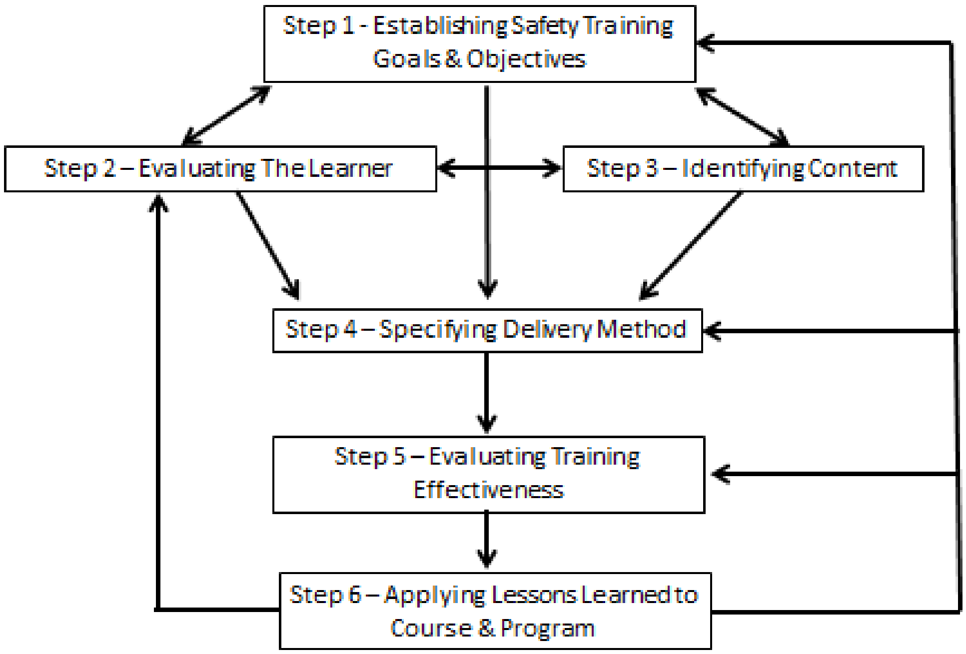


Figure 1 – Proposed Model for Development & Evaluation of Safety Training

In a recent literature review funded by the National Institute of Occupational Safety & Health (NIOSH), four categories of learning outcomes were identified: knowledge (typically shown via a written exam covering a particular policy, procedure or hazard), attitudes & beliefs (including perception of risk), behaviors (meaning worker actions that could result in exposure to hazards) and health (referring to early detection of illnesses/injuries).[4] Knowledge, as shown by successful completion of a written exam, is a common measure of effectiveness in safety training.[5] Equally important to the safety professional is retention of the information received in training which is related to the requirement for refresher training when hazards change or at some prescribed frequency (typically annually). All four of the NIOSH categories are important to consider, but knowledge gain or loss is clearly the most easy to measure and analyze.

**Step 2 - Evaluating The Learner**

The safety professional must consider the potential impact of characteristics of the learners taking the same safety training course in order to deliver the best safety training. For example, Kirsch et al. recently reported that literacy amongst the U.S. workforce is eroding and will continue to do so until 2030.[6] From this information, the safety professional might conclude that a verbal presentation of safety information is more effective than a written presentation. Umbrell reported that some global workforces have as many as five generations of workers, each with differing cultural and education backgrounds, who share the same safety training program![7] Despite the complexities suggested by the previous examples, it clearly behooves the safety professional to give some consideration to the characteristics of learners when devising a training course.

**Step 3 - Identifying Content**

Depending on the organization and the size of the safety office staff, the process of establishing identifying essential course content may be done unilaterally by the trainer (generally a subject matter expert) or as a part of collaborative effort by several safety professionals with relevant expertise.

**Step 4 - Delivery Method**

Burke classified levels of training engagement as low, moderate and high. Lectures are an example of low engagement or “passive” training that are “commonly used to present health- and safety-related information".[5] Moderately engaging techniques include demonstration of knowledge via a feedback mechanism that allows the student to correct their own mistakes through feedback from the instructor or, in the case of a computer-based training method, via feedback from the course. Highly engaging training involves a modification of behavior. Which method is best for a given safety course is determined by a variety of factors including learning preferences of the students, teaching preferences of the trainers, organizational goals and available resources.[8]

## Classroom Versus Computer-Based Instruction

The emergence of computer technology has led to extensive use of this delivery method for safety training. Today, there is widespread availability of off-the shelf computer-based training courses from a variety of vendors. Accordingly, extensive research on the effectiveness of classroom versus computer-based training has been conducted and reported in the literature.

Traditional lecture (classroom) instruction has many advantages over other methods including opportunity for discussion and interaction, dissemination of large amounts of information to a large number of people in a short period of time, greater control over whether students finish a course, ease of course development, ability of instructors to motivate students to learn and perform, and wide acceptance as an approach to teaching.[9,10,11,12,13] Potential weaknesses of traditional classroom instruction include passive listening, limited trainee involvement, limited effectiveness of skill acquisition, limited skill and effectiveness of the trainer, diminished control over relevance of material presented, limited or fixed time for presentation and limited individual attention or instruction.[14,15,16,17]

Advantages of computer-based instruction have also been well documented and include increased accessibility, individualized self-paced instruction, automated recordkeeping, control of the training process, not subject to the skills and availability of an instructor, potential for reduced training time, program interactivity, timely and targeted feedback and reinforcement, individualized instruction, reduced likelihood of error in presentation of content, and consistency in presentation.[18,19,20,21,22,23,24] Developmental costs have been previously discussed, but several studies have suggested that long-term benefits may outweigh costs.[25,26,27] Other disadvantages discussed in the literature include computer phobia and anxiety [28] and lack of acceptance by instructors.[29]

**Step 5 - Evaluating Safety Training Effectiveness**

Evaluating the effectiveness of safety training is critical. Sugure & Rivera report, however, that only about 50% of companies measure learning outcomes from training, and less than 25% make any attempt to assess potential programmatic improvements resulting from training.[30] The National Institute for Occupational Safety and Health (NIOSH) makes a compelling case for the need to evaluate safety training effectiveness:

> Research on the effectiveness of Occupational Health and Safety (OHS) training is needed to: 1) identify major variables that influence the learning process and 2) optimize the allocation of resources for training interventions. In research on training, it is often difficult to arrive at definitive conclusions about effectiveness. Typically, many workplace characteristics contribute to real-world effects of training. Designing

> studies that validate the unique contribution of individual factors, such as specific training program features, are often infeasible. Traditional narrative literature reviews of training are often speculative about specific factors that enhance the relative effectiveness of OHS training interventions in reducing occupational injuries, illnesses and deaths. [4]

Since both classroom and computer-based instruction are common, research has been conducted on both learning and retention.

**Learning**

Differences in demonstrated learning between classroom and computer based instruction have been studied extensively across many disciplines including safety. Lawson evaluated a group of 46 college students who were receiving OSHA blood borne pathogen training via either CBT or the classroom. [31] Students were administered a 30-question, multiple-choice pre-test and post-test (upon completion of training). The results indicate that CBT students scored higher on a post-test administered immediately after training than instructor-led students (an average of 85.7% for CBT versus 64.7% for instructor-led). In the more specific area of chemical safety, Williams and Zahed (1996) looked at 54 employees of a chemical processing plant who received chemical hazard communication training via CBT or classroom. Their results indicate that there was no difference in learning (as indicated by a post-test) immediately after completion of the training.[32] As straightforward as these results might appear, it should be noted that there is inherent complexity in understanding the teaching-learning relationship. It could be hypothesized that this is the reason for the current popularity of using exam scores to determine whether or not “learning” has occurred.

**Retention**

The amount of retention occurring between classroom and computer-based instruction has also been reported in the literature. Lawson, referenced earlier (see Learning), also evaluated retention with the same group of 46 college students. Students were administered another 30-question post-test three weeks later. Results indicated that both groups experienced a similar amount of decrease in test scores after 3 weeks.[31] Booker, Catlin & Weiss administered a follow up test and questionnaire one year after initial training to a group of 114 asbestos workers and found that retention was better on specific work practice questions than those dealing with other issues. Their results provided an opportunity to assess the original training but the study was not designed as an evaluation effort.[33] Williams and Zahed noted that retention of chemical hazard communication information after one month was higher for students taking computer-based training than for classroom instruction (85.30% test scores on CBT versus 78.74% for instructor-led).[32] Interestingly, a NIOSH review of recent literature (1996 to present) identified very few studies of safety training that evaluated long term retention and no studies in the chemical safety arena.[4]

**Step 6 – Applying Lessons Learned to Course & Program Improvements**

Despite the many demands on the safety professional's time, regular review of the training program and specific training courses is imperative. Are there differences in the amount of learning between the two delivery methods? Are there certain learner characteristics that affect amount of learning? There are a myriad of questions that can be evaluated via a comprehensive assessment of safety training effectiveness.

## Research Objectives

Given the widespread use of computers as a delivery method and the prevalence of low-engagement, exam-based formats for safety training courses, a large scale research study was conducted that evaluated the effectiveness of a site-wide chemical safety training course. The following research questions were defined:

***Evaluate levels of learning between trainees receiving chemical safety instruction via computer-based training versus classroom instruction.***

In addition, learner characteristic data were collected and analyzed for any impact on effectiveness as measured by amount of learning as demonstrated by performance on a written exam. An associated second research question is as follows:

***Evaluate the impact of a variety of characteristics on learning and retention between trainees receiving chemical safety instruction via computer versus classroom instruction. Specifically, data was collected on age, gender, ethnicity, English language proficiency, amount of previous experience working with chemicals, number of chemical safety courses taken previously, overall satisfaction with training and delivery method preferences.***

Finally, an analysis of the amount of retention occurring after 1-year was also assessed. The associated research question is as follows:

***Evaluate levels of retention of chemical safety information after 1 year by trainees receiving computer-based training versus classroom instruction.***

The results of the study were used to identify lessons learned that could be applied to programmatic and course improvements. An additional purpose was to demonstrate simple techniques that can be used or adapted for use by other safety professionals when evaluating the effectiveness of a low-engagement, exam-based safety training course.

## Materials & Methods

Specific steps in the study methodology were defined in conjunction with the six-step model discussed previously.  A brief description of each step and the associated research component is as follows:

### Step 1 – Establishing Goals and Objectives

Goals and objectives of the training were established by a convened “expert panel” comprised of chemical safety specialists on campus. The primary learning outcome of the training was demonstrated knowledge via a written exam on the following programmatic elements:  pertinent OSHA requirements, roles and responsibilities of chemical users, how to obtain Material Safety Data Sheets (MSDSs), requirements for container labeling, how to select appropriate Personal Protective Equipment (PPE), procedures for handling emergencies, and procedures for handling workplace events such as an accident.

### Step 2 – Evaluating the Learner

In order to evaluate the learner, a survey mechanism was defined by which key characteristic data could be collected by participants in the project.  Specific demographic characteristics were: age, gender, ethnicity (White (non-Hispanic), Black (non-Hispanic),

Hispanic, Native American, Asian), English proficiency (beginner, moderate, proficient, highly proficient), education level (high school diploma, some college, 2-year degree, 4-year degree, Master’s, Ph.D./Ed.D.) , number of previous chemical safety training courses taken (0, 1, 2, 3 or more), number of years experience working with chemicals (0, 1, 2, 3 or more), overall satisfaction with the training experience (very satisfied, somewhat satisfied, somewhat dissatisfied, very dissatisfied) and preferences on delivery method (computer versus classroom).

**Step 3 – Identifying Content**

Identifying appropriate content was also the task of the convened expert panel. During the course of establishing goals and objectives, the expert panel also engaged in the task of determining appropriate course content. The job of the expert panel was to come to a consensus on identifying those topics for inclusion in the training.

**Step 4 – Specifying Delivery Method**

The chosen chemical safety training laboratory fundamentals course was already being offered in two formats: classroom and computer-based. However, to accommodate a data collection mechanism, significant review and modification of the two delivery methods (computer, classroom) was necessary. The classroom session was approximately 90 minutes in duration. A pre-test was given prior to the commencement of training; the first post-test was administered immediately upon the conclusion of training; the second post-test was administered at the one-year anniversary of completion of training. Similarly, the computer-based module was approximately 60 minutes in duration. The pre-test was administered electronically, after the participant agreed to be in the study, with the first post-test being administered upon the completion of training. The second post-test (in hard copy form) was sent to participants at the one-year anniversary of completion of training.

**Step 5 – Evaluating Effectiveness**

To collect data on learning, a pre-test/post-test format was utilized that was similar to a study conducted by Williams & Zahed.[32] Specifically, the difference between pre and post-course scores on a 16-question Learning Assessment Tool (LAT) was interpreted as a measure of amount of learning. To accommodate the necessary pre- and post-test strategy, three different versions of the LAT were developed. Since each version contained 16 questions, it was necessary to develop and validate a master question set totaling 48 questions (3 questions per topical area). The LAT version administered as the pre-test was randomly selected; the post-test was a different, randomly selected version of the LAT. Individual questions were tested to ensure strong correlation within each subject matter. The learner characteristic survey discussed previously in Step 2 was also administered after completion of the course. Data analysis on differences in learning consisted of a variety of t-tests and analysis of variance (ANOVA) models.

**Step 6 – Apply Lessons Learned to Course and Programmatic Improvements**

Date collected was synthesized into an overall assessment of effectiveness that included suggestions for future improvements. This information is included in the Results & Discussion sections as well as the Summary & Conclusions sections.

## Results & Discussion

The mean score on the pre-test was XX for classroom participants and XX for computer participants. The mean scores for the post-test immediately following training were XX and XX for classroom and CBT respectively. The mean scores one year after training were XX for classroom participants and XX for computer participants. Table 1 shows summary statistics (means, 95% confidence intervals) for each assessment.

| | **Pre** | **Post1** | **Post2** |
|---|---|---|---|
| **Classroom** | Mean: 12.03<br>95% CI: (11.6, 12.5) | Mean: 13.43<br>95% CI: (13.0, 13.9) | Mean: 13.24<br>95% CI: (13.0, 13.7) |
| | n = 91 | | n = 56 |
| **Computer** | Mean: 11.83<br>95% CI: (11.4, 12.2) | Mean: 13.64<br>95% CI: (13.4, 13.9) | Mean: 13.05<br>95% CI: (12.6, 13.5) |
| | n = 151 | | n = 72 |

Table 1 – Mean & 95% Confidence Interval (CI) Data

The following results and discussion are presented within the context of the pertinent research question.

***Evaluate levels of learning between trainees receiving chemical safety instruction via computer versus classroom instruction.***

To assess the differences in learning between the two populations as a whole, the mean difference between pre and post-course Learning Assessment Tool scores (as measured by  the increase or decrease in number of questions correct out of 16 questions) was calculated (Delta 1).  A t-test analysis was conducted comparing the two population means for Delta 1 and is shown Table 2.  The -1.23 result indicates that the difference between the two increases is not significant. The practical conclusion from this data is that the two delivery methods, classroom and computer, provide equivalent learning equivalent learning experiences for participants.  Implications of this finding are discussed in the Summary and Conclusions section.

***Evaluate the impact of a variety of characteristics on learning between trainees receiving chemical safety instruction via computer versus classroom.  Specifically, data was collected on age, gender, ethnicity, English language proficiency, amount of previous experience working with chemicals, number of chemical safety courses taken previously, overall satisfaction with training and delivery method preferences.***

Given the availability of learner characteristic survey data, a more detailed evaluation of learning differences between the two populations was possible.  Basic summary statistics are shown in Table 3.  A total of 92 participants took training in the classroom; 151 participants completed training on the computer.  Age distribution data were stratified into seven categories and show that the majority of participants in both delivery method groups were in either age 20- 24 or age 25-30 groups (classroom = 80%; computer = 64%).  This is not surprising and reflective of the fact that most of the study participants were students at Iowa State University (ISU).  The gender breakdown for each delivery method was unremarkable with a male/female split of 66%/34% for the classroom participants and 54%/48% for the computer.  Certain ethnic categories were not able to be analyzed due to lack of data (e.g. no Native American participants in either type of training; no Hispanic participants in classroom delivery). In terms of English proficiency, there were low total numbers of participants that rated themselves as either a "beginner" or as having "moderate" proficiency. This is perhaps a function of ISU being an academic institution where a basic language of English proficiency is required. The academic environment also explains the relatively even distribution of varying levels of academic achievement up to and including doctoral degrees. The majority of study participants had some prior chemical safety training with 25% of classroom and 23% of computer participants having no previous chemical safety training.

Similarly, in terms of experience with working with chemicals, 28% of the classroom and 30% of the computer participants reported no previous experience. Ninety-seven percent (97%) of classroom and 80% of computer participants reported being very or somewhat satisfied with the training experience. In terms of delivery method preference, 57% of the classroom participants said the classroom method was preferred while 90% of the computer participants said the computer method was preferred.

An analysis of variance (ANOVA) model was used to evaluate differences in learning as measured by exam score (Delta 1) that may be influenced by the selected characteristic categories. ANOVA evaluates the observed variance in Delta 1 values and partitions it into attributable components. [34] As mentioned earlier, some categories had small numbers, so a minimum of 10 data points was chosen as a cut-off point so as to provide statistical validity to the analysis. In the statistical model tested, Delta 1 was the dependent variable with the various characteristics and classroom versus computer being independent variables. Given the previous criteria, all possible ANOVA models were tested and none were found to be significant at a $p = 0.05$ level. The practical conclusion from this data is that learner characteristics had no impact on

| **Delivery Method** | **Mean (95% Confidence Interval)** | **Standard Deviation** | **T-statistic** |
|---|---|---|---|
| Classroom (n = 92) | 1.40<br>(0.91, 1.89) | 2.38 | -1.23<br>(df=204; p=0.22) |
| Computer (n = 151) | 1.80<br>(1.38, 2.2) | 2.63 | |

Table 2 – T-test Analysis of Average Increase in Exam Score (Delta 1)
as Measured by Number of Questions Correct
(Difference in Pre- and Post-Test Score)

| Characteristic | Classroom | | Computer | |
|---|---|---|---|---|
| Age | <19 – 5 (5%) | 41-50 – 0 | <19 – 12 (8%) | 41-50 – 10 (7%) |
| | 20-24 – 53 (58%) | 51-65 – 5 (5%) | 20-24 – 71 (47%) | 51-65 – 7 (5%) |
| | 25-30 – 20 (22%) | >65 - 0 | 25-30 – 26 – (17%) | >65 - 0 |
| | 31-40 – 8 (9%) | | 31-40 – 25 (16%) | |
| Gender | Male – 61 (66%) | Female – 31 (34%) | Male – 79 (52%) | Female – 72 (48%) |
| Ethnicity | White (Non-Hisp) - 58 (63%) | Native American – 0 | White (Non-Hisp) – 115 (76%) | Native American – 0 |
| | Black (Non-Hispanic) – 5 (5.4%) | Asian – 29 (32%) | Black (Non-Hispanic) – 5 (3%) | Asian – 24 (16%) |
| | Hispanic - 0 | Other - 0 | Hispanic – 4 (3%) | Other – 3 (2%) |
| English Proficiency | Beginner – 0<br>Moderate – 8 (8.6%)<br>Proficient – 27 (29%)<br>Highly Proficient – 57 (62%) | | Beginner – 4 (3%)<br>Moderate – 3 (2%)<br>Proficient – 31 (20%)<br>Highly Proficient – 113 (75%) | |
| Educational Profile | High School - 6 (7%) | 4-Year – 33 (36%) | High School – 7 (5%) | 4-Year – 49 (32%) |
| | Some College – 23 (25%) | Master's – 19 (21%) | Some College – 38 (25%) | Master's – 27 (18%) |
| | 2-Year – 1 (1%) | Ph.D./Ed.D. – 11 (9%) | 2-Year – 4 (3%) | Ph.D./Ed.D. – 26 (17%) |
| Prior Chemical Safety Training | 0 courses – 25 (27%) | 2 courses – 14 (15%) | 0 courses – 34 (23%) | 2 courses – 19 (13%) |
| | 1 course – 35 (38%) | 3 or more - 18 (20%) | 1 courses – 35 (23%) | 3 or more – 53 (35%) |
| Years Experience | 0 years – 28 (30%) | 2 years – 29 (19%) | 0 years – 45 (30%) | 2 years – 29 (19%) |
| | 1 year – 22 (24%) | 3 or more years – 28 (30%) | 1 year – 12 (8%) | 3 years – 65 (43%) |
| Overall Satisfaction | Very satisfied – 62 (67%) | Somewhat dissatisfied – 2 (3%) | Very Satisfied – 45 (30%) | Somewhat dissatisfied – 14 (9% |
| | Somewhat satisfied 28(30%) | Very dissatisfied – 0 | Somewhat satisfied – 76 (50%) | Very dissatisfied – 2 (1%) |
| Delivery Method Preference | Classroom – 52 (57%); Computer – 38 (42%); Either - 2 | | Classroom – 14 (9%); Computer – 135 (90%);Either – 2 | |

Table 3 – Learner Characteristic Summary Data

learning as measured by exam score (Delta 1). The implications of this will be discussed in the Summary and Conclusions sections.

***Evaluate levels of retention of chemical safety information after 1 year by trainees receiving computer-based training versus classroom instruction.***

For the second phase of the study evaluating retention, a total of 56 individuals taking classroom training and 72 individuals taking computer training agreed to participate. An identical statistical set of analyses was done to evaluate the issue of retention of chemical safety information after 1 year. To assess the differences in retention between the two populations as a whole, the mean difference between first post-course Learning Assessment Tool score and the second Learning Assessment Tool administered one year later (as measured by the increase or decrease in number of questions correct out of 16) was calculated (Delta 2). A t-test analysis was conducted comparing the two population means for Delta 2 and is shown Table 4. The -1.40 result indicates that the difference between the two decreases is not significant. The practical conclusion from this data is that training participants lost about the same amount of knowledge after 1 year, regardless of how the training was delivered. The implications of this will be discussed in the Summary and Conclusions section.

As was done with learning (Delta 1), an ANOVA model was used to evaluate differences in Delta 2 that may be influenced by the selected characteristic categories.

| **Delivery Method** | **Mean (95% Confidence Interval)** | **Standard Deviation** | **T-statistic** |
|---|---|---|---|
| Classroom (n = 56) | -1.06 (-1.81,-0.31) | 2.86 | -1.40 (df=59,p=0.16) |
| Computer (n = 72) | -0.17 (-0.73, 0.39) | 2.43 | |

Table 4 – T-test Analysis of Average Decrease in Exam Score (Delta 2) as Measured by Number of Questions Correct (Difference in Post 1 and Post-Test Scores)

Categories with a minimum of 10 data points were analyzed with Delta 2 being the dependent variable and the various characteristics and classroom versus computer being independent variables. Given the previous criteria, all possible ANOVA models were tested and none were found to be significant at a $p = 0.05$ level. Similar to learning, the practical conclusion from this data is that learner characteristics had no impact on amount of retention as measured by exam score (Delta 2). The implications of this will be discussed in the Summary and Conclusions section.

## Summary & Conclusions

The summary statistics on learner characteristics along with the T-test and ANOVA analyses can be used to shed light on potential implications for future training endeavors.

### Learning

The T-test results for differences in learning as measured by exam score (Delta 1) show that participants taking chemical safety training in the classroom or on the computer learn the same amount of information. It should be noted that the two versions of the training course were identical and considered to be high quality. This would support an overall conclusion that both delivery methods provide an equivalent learning experience for the participant. The ramifications of this finding are potentially significant to ISU (or any organization). One potential cost-savings measure is to reduce the amount of staff time spent in the classroom. If the safety professional wanted to reduce time spent conducting safety training, confirmation of an equivalent learning experience being provided by the computer-based version of a course would support a reduction in or even elimination of the number of classroom-based offerings. The safety professional could then devote time to other aspects of the overall safety program.

**Retention**

The T-test results for differences in retention as measured by exam score (Delta 2) show that there is comparable loss of chemical safety information over the course of a year and that there is no significant difference based on delivery method used. These results need to be considered within a certain context. Participants taking this type of training would be expected to use the knowledge as a part of day-to-day activities and thus retain a higher level of knowledge. Conversely, participants taking cardiopulmonary resuscitation (CPR) classes, for example, don't typically use the knowledge learned on a regular basis, and thus may be more in need of refresher training. As a result, this finding would be helpful when evaluating issues related to the administration of refresher training. If it has been shown that very little programmatic knowledge is lost over the course of one year, a prescriptive requirement for annual refresher training may be, in fact, a waste of human resources including time spent by the safety professional teaching and training participants sitting through a class (either in the classroom or in front of the computer). If the annual refresher training is mandated by law, an alternative means of showing competency could be devised. One option is demonstrating knowledge by successful completion of a "challenge exam". A potential format would be to post the exam on a website that could be accessed by training participants. The exam would be administered, scored and could provide immediate feedback on results to the participant. If a passing score was achieved, a training certificate would be generated and there would be no need to take a refresher class. If the participant failed to achieve the minimum score, directions on how to complete the refresher training course would be given. Again, applying the methodologies used in this study to confirm retention in other courses could result in additional organizational savings.

**Learner Characteristics**

ANOVA analyses were done to determine if learner characteristics resulted in any differences in learning and retention. No characteristics had a significant effect on either of these defined dependent variables. However, the methods used to collect key characteristic data of the participant should be considered a part of an overall evaluation of effectiveness. Although none of the selected characteristics were found to impact learning (as measured by exam score), further study might reveal other characteristics that, in fact, do impact learning. In addition, recall that learning as measured by exam score is one of the easiest learning assessment techniques to evaluate. Learner characteristics may turn out to have a much greater impact on the other the learning outcomes identified by NIOSH. For these reasons, the importance of evaluating the learner can't be dismissed and may indeed have implications for both delivery methods.

**Recommendations for Future Research**

Paradise reported that the total cost of employee training in the United States exceeds $126 billion annually.[35] The financial stakes involved with implementing a training program are significant and demand that this be a key focus area for every organization. The results of this study would also allow cost savings from the standpoint of both the trainer and the participant. As most organizations are continually evaluating ways to reduce costs, the data generated by the mechanisms discussed in this study will allow the training program to be a part of an overall discussion about cost-savings. The data would also show that cost-savings are occurring without sacrificing “quality” in terms of providing equivalent learning experiences. Assuming that the methodologies used in this study could be applied to other safety training courses, there is potential for this trend to continue and result in further savings to the organization.

While the data generated in this study suggest equivalent learning experiences, it is important that our results not be used to predict similar outcomes in other work environments. However, the data collection techniques presented are simple and easily utilized by other safety professionals in the field to evaluate the effectiveness of the safety training they provide.

While costs savings are certainly important, additional studies are necessary to shed further light on issues related to the effectiveness of safety training. The call for more research by NIOSH was quoted earlier and was based on a literature reviewed conducted in 2010. In order to further advance the state of knowledge on the connection between training and injury/illness reduction, more safety professionals must get involved in examining and reporting issues related to learning, retention, characteristic variables and assessment techniques. This study only looked at one type of outcome (knowledge). Clearly, the other outcomes also need to be studied and will likely involve more difficult analytical techniques. It should be clear that the current amount of understanding on this topic, as evidenced by a limited body of scientific literature to date, is still in its infancy.

In conclusion, the methodologies presented in this paper should be considered for use by safety professionals in other work settings.  The value of evaluating safety training effectiveness cannot be overstated.  The secondary benefit of potential cost reductions have been discussed and may be significant.  Only by taking a critical look at how well training is working and using some of the tools discussed in this paper, will the safety professional and organizational leadership have assurance that employees are being provided quality, cost-effective as a part of an overall workplace safety program.

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