Investigation of the Impact of Learning Community Immersion on Chemical Hazard Communication Awareness and Knowledge

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Abstract

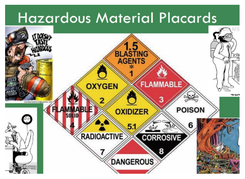
This study was done in order to compare the effectiveness of chemical hazard training and student commitment to best practices as a consequence of exposure to standard "in-lab" content lectures and quizzes versus immersion in a chemical hazards communication learning community setting. Learning communities are considered high impact practices (HIPs) which are reported to induce deeper learning and greater commitment to training principles. This comparison was done with freshmen college students enrolled in first year chemistry labs. Surveys measuring chemical hazard awareness, knowledge, and commitment to best practices were constructed and delivered prior to and following structured chemical hazards training within lab or within a learning community. The chemical hazards studied will concentrate on common household chemicals and their content, knowledge of side effects, precautions being taken with use, disposal methods, and resources to determine content. This study may provide evidence for universities to use learning communities to train chemical hazard practices during first year science studies and beyond.

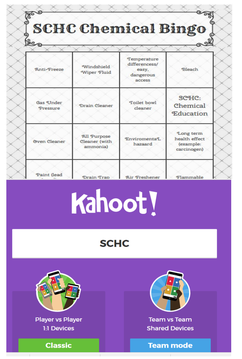
Background

It is becoming increasingly more important to upgrade chemical hazard education in undergraduate chemistry programs (lab-safety). Traditional undergraduate chemical hazard training is usually focused on limited to basic lab safety procedures including eye protection, use of gloves, and proper disposal methods which are introduced at the beginning of the freshman chemistry lab experience and fundamentally assumed to be learned and carried through graduation. Students may be quizzed on some elements of the subject, but typically only verbal reinforcement is used and it is not always formalized. While this approach is appropriate and acceptable for baseline, it would very useful to extend this kind of training and to measure the increase in depth of understanding and level of commitment to chemical hazards safety developed in students as a result of extended formal training and inclusion of an associated chemical hazards learning community (LC). Formal Learning Communities (LCs) are designated as High impact practices (HIPs) in higher education, contributing to deep learning and greater student retention in programs, majors and the university in general. This project will focus on developing and testing first stages of such assessment with a rubric-based approach and embedded extended training in first year college chemistry lab, both including and excluding a formal chemical hazards learning community.

Experiment

This experiment tested the level to which learning communities assisted in the ability to retain information regarding chemical hazards in comparison to a non learning community (control) group. The experiment consisted of 66 general chemistry laboratory students (58% Freshman, 30% Sophomores, and 12% Juniors). The participants were 62% female and 38% male. After placing all 66 participants in a random name generator, 33 students were selected to partake in the non-learning community group and 33 students were selected to partake in the learning community group. The goal of the experiment was to asses which group of students would retain select chemical hazard information to a fuller extent. Before delivering any chemical hazard information, a pre-study survey was administered to all of the participants. Then all 66 participants were exposed to a chemical communication lecture each week at the start of the laboratory class period. The non-learning community group was simply required to attend the lectures and be attentive. The select students in the learning community, however, were required to attend an additional "Learning Community" meeting each week for the duration of the study. The learning community meeting consisted of group discussions involving the weekly hazard lecture. In addition, a review activity of sorts was delivered that presented information in another way that differed from lecture style teaching methods, and involved thorough reiteration of information presented during the lecture that week. These study groups consisted of fluctuating numbers of three to eight people per study session. Following five weeks of interactive lectures, the post-study survey (a scrambled version of the pre-study survey) was administered to all participants in both the learning and non-learning communities. The surveys were then analyzed to determine how participation in a learning community, or lack thereof, affected the students performance on the surveys. Lasly, a set of group problems was developed and administered to the learning and non-learning communities separately in order to evaluate the students knowledge of specific chemical hazard situations. This set of problems was evaluated with a point specific rubric.





Category	4 points	3 points	2 points	1 point
Question 1	Answered All 4 sub questions correctly	Answered 3 of 4 sub questions correctly	Answered 2 of 4 sub questions correctly	Answered 1 of 4 sub questions correctly, at least attempted a partial, correct answer
Question 2	Answered All 4 sub questions correctly	Answered 3 of 4 sub questions correctly	Answered 2 of 4 sub questions correctly	Answered 1 of 4 sub questions correctly, at least attempted a partial, correct answer
Question 3	Answered All 4 sub questions correctly	Answered 3 of 4 sub questions correctly	Answered 2 of 4 sub questions correctly	Answered 1 of 4 sub questions correctly, at least attempted a partial, correct answer
Timeliness	15- Minutes or less to Complete	15- 20- Minutes to Complete	20-25- Minutes to Complete	25-30- Minutes to Complete
Number of Group Members who participated	All members actively participated	Most Members Actively Participated	Some Members Actively Participated	Only 1 Member Participated

Weekly Lectures

Weekly Lectures were focused on specific topics of chemical safety. Each lecture was delivered via power point presentation and lasted ten to fifteen minutes. Some students took notes and some did not. The lectures were delivered to both learning and non-learning community participants simultaneously.

Agenda For the Weekly Lectures:

Week 1: Pre-survey was administered and the study was explained to all of the participants.

Week 2: Topics of lecture included the explanation of various organizations such as OSHA (Occupational Safety and Health Administration), NFPA (National Fire Protection Agency), and DOT (Department of Transportation) as well as the hazardous chemical placards that each organization distributes. Main focus on the Globally Harmonized System (GHS) symbols and pictograms.

Week 3: Topic of lecture involved the thorough explanation of Safety Data Sheets. The power point included SDS layout as well as the benefits of correctly using the SDS in case of chemical emergency. The specific chemicals covered included common kitchen (bleach, oven cleaner, all purpose cleaner with ammonia) and bathroom(toilet bowl cleaner, air freshener, drain cleaner) chemicals.

Week 4: Topic of lecture focused on garage chemical education with the inclusion of paint, anti-freeze, and windshield washer fluid. Focus on the safety of garage storage, as well as chemical incident prevention in the storage areas.

Week 5:Final week of lecture focused on backyard chemical education including the explanation of pesticides (rodent control, weed killer, and insect repellent) as well as organizations such as the NIH (National Institute of Health) and the IARC (International Agency for research on Cancer) that help to study and regulate the chemicals discussed in the previous lectures.

Week 6: Post-survey was administered. Both learning community participants and non-learning community participants participated in group problem sets.

Learning Community

The Learning Community consisted of 33 participants (half of the total participants). Groups met once a week, for twenty to thirty minutes, following lectures during weeks two (pictograms), three (SDS and common kitchen and bathroom chemicals), four (garage chemical education), and week five (backyard chemical education). Each week consisted of guided discussion and an interactive activity. The learning community sessions were cumulative. This meant that both new information, as well as old information, was reviewed each week.

Topics For Learning Community Meetings:

Week #1: No interactive activity scheduled

Week 2: The interactive activity involved a short clip that reiterated the Globally Harmonized System (GHS) pictograms. Discussion followed that entailed sightings of specific pictograms and precautionary measures to be taken if one may have encountered said pictograms in a real life scenario.

Week 3: The interactive activity was "Chemical Jeopardy". The learning community members participated as a group to answer various prompts throughout the game. The focus of the activity was common kitchen and bathroom chemicals and the use of safety data sheets.

Week 4: The interactive activity was "Chemical Bingo". The participants each had randomized bingo cards. This activity emphasized the auditory learning experience. The main focus was on garage chemical education.

Week 5: The interactive activity involved an online game, "Kahoot", which can be customized to be used as a study tool. Essentially, the learning community participants answered multiple choice questions about backyard chemicals, organizations, and regulation of chemicals utilizing personal cellular devices.

Assessment

In addition to the post survey students were presented with a series of scenarios regarding the a chemical hazard situation. The assessment was created and distributed to each group independently (separating the non-learning community and the learning community) The assessment tested a practical application of chemical hazard knowledge. The problems consisted of four scenarios, each with a set of follow-up questions that the groups were asked to develop solutions for. This evaluation would asses the ability of group members to provide chemical hazard solutions in a group setting. This survey also accounted for time constraints and use of available resources (example, 2016 Emergency Response Guidebook). The rubric used to evaluate the group problems can be found at the left.

Results

Survey Questionnaire Results: % Participants Answering Correctly

	Pre-Safety Lecture Survey Results LLC and Non-LLC Participants (n=66)	Post Safety Lecture Survey Results Non-LLC (n= 31)	Post Safety Lecture Survey Results LLC (n= 34)
Section #1	67.6 % (+/- 2.1)	78.1 %(+/- 2.4)	80.1%(+/- 2.0)
Section #2	47.0 % (+/- 2.1)	58.1 %(+/- 2.1)	55.1 %(+/- 4.1)
Section #3	67.6 %(+/- 2.1)	83.9 %(+/- 4.0)	93.5 %(+/- 1.6)

Section #1: Introductory multiple choice survey questions involving: proper storage, harmful effects from exposure, antidotes for ingestion and exposure, precautions for use, and remedy in case of spill.
Section #2: Survey questions with paragraph long matching sets involving: proper storage, harmful effects from exposure, antidotes for ingestion and exposure, precautions for use, and remedy in case of spill.
Section #3: Hazardous material placard identification

Study Participants Self-Evaluation 1-10 (1 lowest- 10 Highest)

	Self-Evaluation Pre-Lecture All Participants (n=66)	Self-Evaluation Post Lecture Non-LLC (n= 31)	Self-Evaluation Post Lecture LLC (n= 34)
Initial Evaluation	6.2 (+/- 0.11)	7.0 (+/- 0.13)	7.1 (+/- 0.11)
Re-Evaluation	4.3 (+/- 0.6))	6.1 (+/- 0.10)	6.4 (+/- 0.05)

A comparative analysis of pre-study to post-study surveys of the learning community vs. non learning community self evaluation revealed the following:

- Prior to being exposed to the Chemical Hazards lectures, the study participants initial rated themselves slightly above average (6.2) in knowledge of chemical hazards and the control group rated themselves even higher. However universally after answering several questions regarding Chemical Hazards, immediately decreased their self evaluation by about 20.0%.
- Post Lecture, this phenomenon persisted, although at a somewhat diminished rate of about 10%.

A comparative analysis of the pre-study vs. post-study surveys was conducted in order to asses retention of material presented in the lecture and reinforced in the Learning community meetings. Success of retention was measured by determining the percent correct answers and comparing the scores of the two groups. In addition, groups were evaluated on performance in hazardous material identification and disposal in the case of an accidental spill.

- The learning community answered the chemical hazard multiple choice questions 80% correctly. This is 26.0% higher than the original pre-study survey results and 2.5% higher than the non-learning community post-study survey results.
- The learning community answered the chemical hazard placard identification matching questions 93.4% correctly. This is 19.2% higher than the original pre-study survey results and 10.0% higher than the non-learning community post-study survey results.
- The learning community answered the chemical hazard chemical identification questions 55.1% correctly. This is 8.1% higher than the original pre-study survey results and 3.0% lower than the non-learning community post-study survey results.

Group Problem Scenarios

- The learning community scored, on average, 91.7%
- The non-learning community scored, on average 91.7%

Conclusion

The results from the study are somewhat inconclusive. Although students improved in their knowledge of Hazardous Material Identification and handling, the learning community out performed the Non-Learning community significantly in only one category, that of GHS pictogram identification. The LLC performed marginally better than the Non-LLC group in answering introductory questions, and slightly worse in the third category which involved reading and assessing more complicated situations. Since these questions were more involved, the students may have given up and guessed. In addition both groups performed identically in handling the case study scenarios. Individuals in the groups for the case studies were permitted to discuss the situation and subsequently fill in gaps of knowledge. The most interesting development was teased from the self-assessment sections of the survey. Students rated themselves average to above average in knowledge prior to answering any survey questions. However, once presented with a series of questions and then asked to reevaluate there knowledge they universally lowered their self assessment drastically. This reinforces the practice of embedding self tests throughout a learning module. In the future shorter questions would be utilized in the survey, the group problems would be presented pre-study and post-study to asses improvement, a non science control group would be utilized, and quizzes after each lecture and LLC meeting would be introduced.