

WIP: Graduate-Student Led Initiatives for Enhanced Safety Learning and an Improved Safety Culture in Engineering Departments

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Abstract—This work-in-progress research-to-practice paper describes the development of safety projects and the implementation of safety-related initiatives to improve the overall safety culture in engineering programs at the graduate level.

Safety in chemical engineering refers to the application of engineering concepts in the identification of hazards, the management of risks, and the prevention of accidents that may result in loss of life and/or property. Multiple studies highlight how the practice of laboratory and process safety in engineering offers educational benefits and opportunities to help the professional development of students; nonetheless, the implementation of these educational experiences has been inconsistent, contributing to a gap in knowledge in engineering graduates. This research addresses graduate safety education. A high percentage of our graduates typically proceed to work in laboratory and/or manufacturing environments that require safety knowledge. Our goal is to contribute to the creation of a homogeneous safety training at the graduate level that prepares students for their careers more effectively.

This study was developed by the Graduate Student Safety Committee at The University of Texas at Austin (GSSC at UT Austin). We are currently working on three projects to improve our departmental safety culture: (1) the deployment of safety-related flyers on campus, (2) a safety-focused seminar series, and (3) the creation of an engineering safety climate survey. In this manuscript, we describe the development and implementation of our current safety initiatives. We highlight how student-led initiatives can enhance safety culture in engineering departments and we summarize our initial efforts to make safety training at the graduate level more homogenous. We anticipate this work will lead to the creation of a safety training program available to engineering students.

Keywords—safety, graduate education, laboratory, leadership

I. BACKGROUND

Laboratory and process safety in chemical engineering refer to the application of engineering concepts in the identification of hazards, the management of risks, and the prevention of accidents that may result in loss of life and/or property [1] – [4]. Multiple studies highlight how the practice of laboratory and process safety in engineering courses offers educational opportunities to help the professional development of students [1], [3] – [5]; nonetheless, the implementation of these educational experiences has been inconsistent [1], [2], [6] – [8]:

- At the undergraduate level, programs utilize different approaches to integrate safety into their curriculum: some use online training, others elective courses, and a third approach focuses on teaching laboratories.
- At the graduate level, safety is seldom part of the curricula of research-focused programs. Students from different educational backgrounds (e.g., chemistry, biomedical engineering, etc.) may have different levels of knowledge and awareness of safety, and the perception of safety knowledge and safety culture in research laboratories can vary greatly between groups, even within the same department.

We believe these inconsistencies contribute to a gap in knowledge in engineering graduates. A high percentage of our graduates typically proceed to work in laboratory and/or manufacturing environments that require safety knowledge. Our goal is to contribute to the creation of a homogeneous safety training at the graduate level that prepares students for their careers more effectively.

In graduate education and academic research, the practice of safety is often associated with the creation of an effective safety culture and the development of a healthy safety climate [8] – [11]. Nonetheless, due to the broadness and complexity of safety topics, the standardization of safety education in engineering research programs can be challenging [12]. The definitions, language, and expectations for safety practices can vary greatly among disciplines or even among research groups in the same department. In addition, the extent to which lab safety is covered also varies greatly between research groups within the same department as they are independently managed [13]. Looking beyond academia and to industry, the standardization of safety education and management is much more developed [12] – [14].

The creation of a renovated safety culture and a healthy safety climate in an academic environment is a large undertaking [12]. It has been suggested that an institutional, or even department-wide commitment to health and safety can help cement the importance of a safety culture within students [12]. This commitment can take multiple forms including safety officers, a departmental safety committee, and the strong presence of the university environmental health and safety (EH&S) department [13].

This study, developed by the GSSC at UT Austin, pursues the creation of safety initiatives to contribute to the creation of an effective safety culture and a healthy safety climate that results in a standardized safety training for all graduate students. We are currently working on three projects to improve our departmental safety culture: (1) the deployment of safety-related flyers on campus, (2) a safety-focused seminar series, and (3) the creation of an engineering safety climate survey.

In this work-in-progress manuscript, we describe the development and implementation of these safety initiatives. We highlight how student-led initiatives can enhance safety culture in engineering departments and we summarize our initial efforts to make safety training at the graduate level more homogenous.

II. MOTIVATION AND RESEARCH QUESTION

The GSSC focuses on improving laboratory safety in the chemical engineering department. This committee consists mostly of chemical engineering graduate students who partake in a variety of student-led safety initiatives, which are projects aimed at educating the graduate student body on safety and providing them with additional resources to conduct their work in a safer manner. Structurally and functionally, the GSSC is very similar to the previously-reported Laboratory Safety Teams (LSTs) [13]. Notably, the GSSC has “champions,” or department faculty and staff who advise the students on their initiatives and provide long-term stability in the organization as students enter and leave the institution. The current GSSC initiatives are also similar to those done in LSTs.

As a committee, we are particularly interested in the creation of safety awareness, the enhancement of our safety culture, and the improvement and standardization of safety learning. By the development of our initiatives and the completion of this study, we will answer the following research question:

Does the development of student-led safety initiatives enhance the safety culture, safety awareness, and learning in graduate engineering programs?

In the following sections of this WIP paper, we summarize initiative development, departmental implementation, and observational data on its initial benefits.

III. INITIATIVE DEVELOPMENT AND IMPLEMENTATION

In this section, we detail the implementation and initial results from our three initiatives as we have focused on the creation of student led projects to enhance our safety culture.

A. Initiative 1: Safety Flyers

A major component of the creation of a renovated safety culture is the enhancement of safety awareness. We have identified the implementation of safety flyers as an effective way to increase exposure to safety related topics [15]. To accomplish this objective, we have installed flyers that include eye-catching graphics and concise information about common lab issues to help researchers consider their safety practices and become more aware of hazards in their labs [15]. The creation of these flyers seeks to address general awareness over lab safety issues.

Flyers were made and installed by the GSSC. Students participating in this initiative were asked to critically think about their experiences and what they believe would be helpful on a

flyer. Using inspiration from the EH&S department, their own experiences in the laboratory, and discussions with colleagues, the students designed flyers using presentation software (i.e., PowerPoint). The goal was to design an informative infographic. Additionally, students designed the flyers to be concise, reducing word count when possible and utilizing pictures to convey information. The GSSC reviewed, discussed, edited, and then distributed these flyers.

Deployed safety flyers aimed to quickly convey important information about various safety topics such as cryogenic safety, lab coat cleaning, and ergonomics. Students in various research concentrations designed the flyers in order to encompass a diverse set of topics that would be relevant to as many researchers as possible, thus attracting more attention and improving awareness. Examples of previously implemented flyers are depicted in Fig 1. As shown in Fig. 1, the safety flyers aim to improve safety culture by covering specific topics that are easy to address, such as maintaining a clean lab coat (Fig. 1C). Some flyers aim to make a reader aware of a topic and consider their own practices; for example, the flyer in Fig. 1A aims to convey the importance of maintaining a clean lab. Other flyers aim to teach or remind researchers of a topic they may not be familiar with, such as the flyer in Fig. 1B which discusses cryogenic safety.

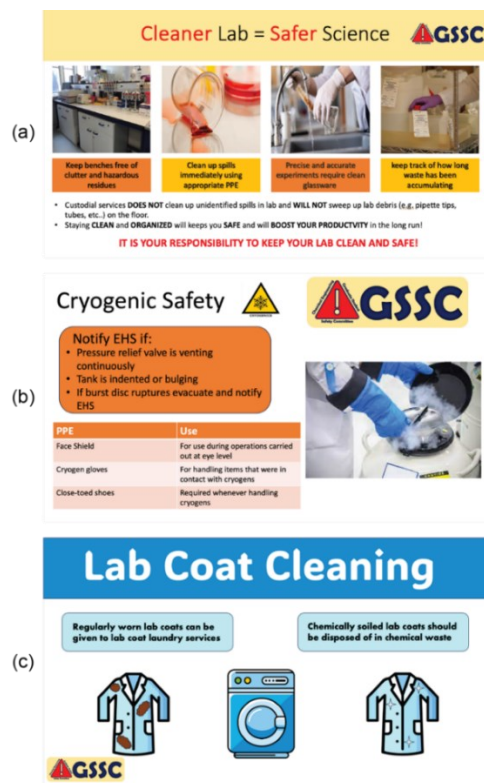


Fig. 1. Three examples of flyers that were deployed by the GSSC. Topics included (a) maintaining a clean lab space, (b) cryogenic safety, and (c) cleaning and disposing of lab coats.

B. Initiative 1 Implementation

The flyers are changed at the start of each semester and are installed in plastic sleeves on the bathroom doors of the main chemical engineering buildings on campus. An example of

implementation can be seen in Fig 2. As this is a relatively new initiative, the safety committee is learning what designs work best. Some flyers appear to have too many words, or very small fonts. Additionally, using brighter colors could improve the flyer appearance so the writing is not lost in the background color. As the flyers were designed only by the student members of the GSSC, there could be an opportunity to improve the topics and impact of the flyers by surveying the department members. In the future, the managers of the safety flyer design and distribution initiative can reach out to the community for additional ideas as well as feedback.

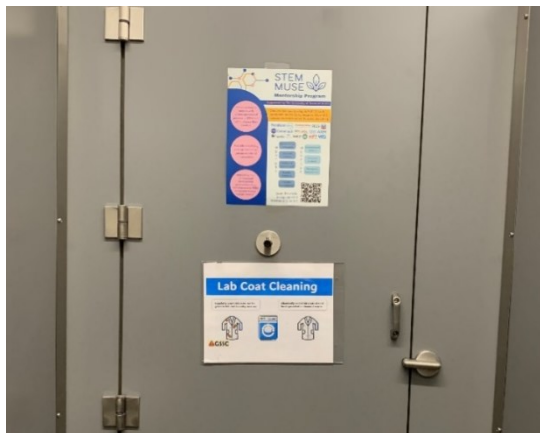


Fig. 2. An example of implemented safety flyer in a bathroom.

We believe that the implementation of laboratory safety flyers can help researchers follow proper protocols by acting as gentle reminders to consider various safety issues and enlighten them about safety practices they may not have known. While the eventual goal is to understand more rigorous and standardized laboratory safety education practices, safety flyers provide an avenue for increasing awareness of lab safety at a student level. Safety flyers are not only useful for departments as a whole and a general audience, but also to those who design and implement the flyers. Student-designed safety flyers allow lab members to come up with their own ideas, causing them to critically think about the safety culture in their lab. The hope is that those viewing the safety flyers will not only learn something new or remember important information, but for them to also consider their own experiences and how they may contribute to their lab's safety practices.

Though an official survey has yet to be conducted, for the purposes of this report, graduate students in the chemical engineering community who are not a part of the safety committee were asked to comment on the safety flyer initiative. One student said "Yes, I have noticed the flyers. They are very readable". Another student said, "I notice the flyers, I like that they are changed regularly". These comments suggest that the safety flyers address our main goal, improving awareness of laboratory safety issues.

C. Initiative 2: Safety Seminars

Our safety seminar initiative invites professionals from different industries to our campus to host 30–60-minute

lectures or discussions on safety topics pertinent to graduate students. Our initiative was born from a general student feeling that there was limited knowledge about career opportunities in safety for graduate students.

By inviting industry safety professionals to speak with our graduate students, we hope to instill some of the safety culture present in industry at the graduate level, as many students who aspire to hold industry jobs will model their behaviors after these representatives. Additionally, students who wish to pursue careers in industry will gain a better understanding of the working environment of an industry-based lab as well as a unique networking opportunity. This initiative also serves to strengthen ties between the chemistry and chemical engineering departments and industry, providing pathways to internships, collaborative projects, and scholarships. We expect most seminar participants to be university alumni working as safety professionals in chemical-engineering related industries. Participants will engage in a full-day visit that will also help enhance our relations with our industry collaborators. We also hope that these seminars can serve as an example for the rest of the school of engineering and subsequently other departments that engage in laboratory work. To our knowledge, the effects of safety seminars on campus safety culture has yet to be studied, and we will elucidate our findings in our future work.

D. Initiative 2 Implementation

The first safety seminar of this initiative, which we coined "Safety and Sweets", was made optional for students in the chemical engineering department to attend. This event was open to students of the chemistry department as we felt lab work in both departments was similar in nature. After reaching out to department alumni and collaborators employed in process safety positions, we were able to schedule a seminar time with a safety professional from a large chemical company. We advertised this seminar to students via social media. Coffee and snacks were provided to encourage attendance.

The seminar, which was one hour in duration, opened with the speaker introducing his qualifications as well as delving into details of his employment using a slide presentation. He then opened the floor to students to pose questions regarding safety in industry, as well as job specifics. Our attendance for the first seminar numbered around 15 graduate students, split fairly evenly between the chemistry and chemical engineering departments. This headcount was lower than what was initially expected and will impact the way we advertise these events going forward. The authors report anecdotally that members of the department did not know that the event was occurring at all, thus limiting the number of attendees. In the future we must be more proactive in advertising the event, not just over social media but also via email.

Initially, we had expected the seminar speaker to lecture from a preset deck of slides, similar to an academic seminar. However, we noticed that when he opened up his time to questions, students were very engaged. There was sustained dialogue between multiple students and the speaker for the entirety of the seminar timeframe. This success in terms of

student engagement has led us to rethink our next planned seminars. We plan to evaluate if smaller group sessions with safety professionals will be more useful for students.

We believe this event to be a success for the students in attendance. They were able to learn from a process safety professional at a large renowned chemicals corporation in an intimate setting. However, we believe that there are many more graduate students we can reach with this initiative, and we plan to improve our advertisement techniques going forward. Over time we plan to collect information such as the attendance and the number of questions asked as well as the content of the questions. By observing the attendance and number of questions, we aspire to pinpoint what types of seminars students are most interested in. Also, if we notice any pattern in the questions asked, we plan to offer them to the seminar speakers as a general outline of what they should cover in their presentations.

E. Initiative 3: Safety Climate Survey

While many educational resources on safe lab practices have been made available (e.g., trainings from EH&S departments) with the intent of enabling and promoting safe practices amongst university researchers, as previously discussed, safety needs can greatly vary between universities and even different departments and laboratories within these universities [12], [13]. Safety climate, which has a substantial impact on the extent to which safety is prioritized by members of an organization, can also greatly vary between these units [14]. Therefore, it is critical for departmental leadership to identify safety-related needs and assess the safety climate within their organizations. Armed with this knowledge, they can effectively design safety resources, programs, and practices that are suited to their safety climate and current research activities [16].

Though substantial research has been done on assessing the safety cultures within organizations, few studies have specifically focused on methods for assessing safety culture within university research laboratories and academic departments. Additionally, to the best of our knowledge, no other studies have reported on safety culture at the graduate level in chemical engineering programs. Some studies have reported on safety perceptions in different university settings such as chemistry laboratory courses [17].

To explore the safety culture in our department, we have developed a survey to assess the safety perceptions and practices of graduate students. Insights gained from the results of this survey will be used by the GSSC to identify safety-related areas of need in our department, tune our ongoing initiatives to better suit these needs, and guide the creation of new initiatives in the future. Furthermore, the survey created in this work or variations of it could be used in other engineering departments to identify their specific needs in relation to safety, which could then facilitate the development of safety-focused initiatives led by students, faculty, and staff.

The survey was developed by the GSSC and all survey questions intend to assess the safety culture amongst graduate students. Previous safety-related analyses and discussions in the

university context tend to focus on “wet lab” work that involves the use of hazardous chemicals and machinery [17]. However, to our knowledge, no research has been done on the safety of computational (dry lab) research in the university setting, which includes facets such as ergonomics and incident reporting. Therefore, surveys were developed for two populations of chemical engineering graduate students: experimental researchers and computational researchers. For both types of students, approximately 20 questions were selected related to engagement in safety-related practices, usage of currently-available safety-related resources, the perception of safety culture in our department.

F. Initiative 3 Implementation

The survey will be available to all of graduate students in the chemical engineering department. The potential pool of respondents to the survey includes ~150-200 students. The insights gained from studying both these groups will allow the GSSC to refine its ongoing initiatives, which are mostly geared towards experimental research, while also informing the development of safety-initiatives that will benefit computational researchers in our department.

The survey will be administered in Qualtrics by sharing a link or QR code on a departmental listserv. Students will first be asked basic information such as their year in the program and whether they primarily do experimental or computational research. Experimental researchers will then be asked about a variety of safety-related topics, such as their usage and perception of the incident reporting system, their participation in safe lab practices, and their perception of how much their research group engages in practices that promote safety. Students who engage primarily in computational research will be asked about their participation in and knowledge of safe ergonomic practices, their usage and perception of the incident reporting system, and the extent to which their lab groups discuss safety. All participants’ perception of the safety culture of their research lab and the department will be gauged by providing them with the opportunity to suggest strengths and weaknesses of these two entities in the context of safety.

After this survey is administered, we will use the collected data to adjust the safety initiatives that are currently underway in the GSSC and develop new initiatives to address any safety-related gaps identified in the responses. Furthermore, the insight gained from data provided by the surveyed computational students could enable the GSSC to expand its scope to include projects related to facilitating safe ergonomic practices in our department.

IV. DISCUSSION AND FUTURE DIRECTIONS

All initiatives have been deployed the 2023-24 academic year. While these initiatives are still in progress, we have learned multiple lessons since we began implementing them.

- Preliminary interviews with students in the department suggest that strategically-placed flyers containing safety information are helpful for disseminating information about lab safety.

- During our first safety seminar with a speaker from industry, students seemed to prefer interactive discussions with the seminar speaker as opposed to a traditional lecture format followed by a question-and-answer session.
- While developing the survey, we decided that safety in computational labs should be considered and studied in addition to safety in experimental labs.

Moving forward, we have the following plans for each initiative:

- The GSSC will continue to deploy a new series of flyers on campus each academic semester. The flyer deployment strategy and the topics on the flyers will be tuned in accordance with information gleaned from surveying the graduate student body.
- Based on the student interest in interactive discussions with the speaker during our first safety seminar in Spring 2024, the GSSC will consider hosting lunches or dinners with professionals from industry and/or EH&S to facilitate safety discussions.
- The survey will be sent out the chemical engineering graduate student body. The results will be analyzed and the insights will be used as an aid to adjust our in-progress initiatives and plan new initiatives.

The GSSC will conduct surveys and/or interviews with chemical engineering graduate students to gauge the impact of our safety flyers and safety seminars on safety culture and education within the chemical engineering department at The University of Texas at Austin. Questions featured on the safety survey will gauge the effectiveness of the flyers in educating our students and improving the awareness of safety in our department. Students will be asked whether they have seen the safety flyers on campus and if so, whether they believe the flyers are helpful. To gauge the effectiveness of the seminar series with respect to safety education, the GSSC will engage in discussions with student attendees to determine whether the topics discussed in the seminars were informative and relevant to their current work or career paths that they are aiming to pursue in the future. Lastly, the GSSC will consult data collected with the safety survey when developing new initiatives to ensure these initiatives are tailored to the needs of the graduate student researchers in the department. This informed design of initiatives will increase their effectiveness at educating students and establishing a safety culture in our department.

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