EXPERIENTIAL LEARNING IN HIGHER EDUCATION FOR THE 21ST CENTURY

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ABSTRACT

Experiential learning is essential in higher education, especially engineering and engineering technology. This paper explores how one program at Oklahoma State University utilizes experiential learning throughout the program to allow students to better grasp concepts through understanding theory and application in laboratory activities. This approach to learning throughout the Fire Protection and Safety Engineering Technology program prepares graduates for careers in risk control positions. This paper discusses students' experiences in classes, how the curriculum is assessed at both the course and program levels, and how virtual environments and experiences can provide additional paths forward in higher education.

INTRODUCTION

Learning through experience has long been a critical component of higher education. Experiential learning is essential in engineering and engineering technology education. Experience criterion is based on two main ideas: continuity and interaction. The concept of continuity is that each experience is built on past experiences and provides for future experiences (Dewey, 1938). Building on this concept, Kolb (1984) developed a learning model consisting of a four-stage cycle where each element builds upon the previous. The four stages include concrete experience, reflective observation, abstract conceptualization, and active experimentation. These stages are then repeated over time to continue building and learning from experiences. *The Fire Protection and Safety Engineering Technology* (FPST) program embraces this methodology, allowing elements to build upon past experiences for learning new material and preparing for future incidents.

Although not required by the institution, the FPST program utilizes concepts of experiential learning throughout the curriculum through lab-based experiences. This approach has long since been the norm in the program, with industry raving about the readiness of the FPST graduates to hit the ground running when starting a job. This paper provides an overview of the FPST program's experiential learning curriculum, the assessment of the experiences, and plans for the program in the post–COVID-19 virtual environment.

Oklahoma State University (OSU) is home to the FPST program, the nation's first Accreditation Board for Engineering and Technology (ABET) accredited Fire Protection and Safety Engineering Technology program. Dating back to 1937, the FPST program is in the College of Engineering Architecture and Technology at OSU. It has eight faculty members and approximately 320 students in both the undergraduate and graduate Fire Safety and Explosion Protection programs. OSU is located in Stillwater, Oklahoma, and had a total enrollment of almost 25,000 in the fall of 2022. OSU is a part of the North Central Association of Colleges and Schools, a regional accreditation association. FPST program graduates protect people and property from fire, chemical releases, exposures, floods, or other disasters. They work in various industries, including design, construction, manufacturing, energy, and insurance.

The FPST program utilizes laboratory classes to provide experiential learning to the students. Laboratories also offer an educational approach beyond the traditional chalk and talk found in classrooms. Laboratories can take many forms, from hands-on and simulation labs to observation labs. The FPST program has nine required courses, including a lab component with hands-on exercises. These courses are program specific and not a part of the general education curriculum requirements. Students in the FPST program start their first year and build upon each other through their senior year. The classes follow two tracks, one more focused on fire protection elements and one more focused on industrial safety elements. These classes then culminate in a final lab course that ties many elements together in risk assessment and control. Below are the methods, objectives, and how they build upon each other.

Fire Suppression and Detection Systems

In the fire protection track, students first take *Fire Suppression and Detection Systems* (FPST 1373). In this course, students are introduced to the design, installation, and maintenance of portable fire extinguishing appliances and engineered systems and the requirements of fire detection and signaling systems. In laboratory activities, students learn how to determine the appropriate number and type of portable fire extinguishers needed to protect a given occupancy or hazard, with recommendations for proper distribution and installation by nationally recognized standards. Students also learn to inspect, test, and maintain standard fire extinguishers, suppression systems, and detection systems found and used in business and industry. Finally, students learn about fire detection systems and best practices for selecting and designing these systems to protect property and life from products of combustion and the effects of fire.

Fluid Mechanics for Fire Protection

The next course students take in this sequence is *Fluid Mechanics for Fire Protection* (FPST 2483). Students learn the science behind fluid flow through pipes, hoses, and fire protection appliances. They test the lab's hydrostatic principles and friction loss theories to compare commonly used industry calculations. They learn water supply systems through hands-on testing and assessment of water supplies and fire pumps.

Design and Analysis of Sprinkler Systems

In *Design and Analysis of Sprinkler Systems* (FPST 2243), students take the knowledge gained from their previous courses and apply it to the design of automatic sprinkler systems. They learn the standard design requirements, hydraulic calculations, and detailed plan preparation. The labs emphasize the practical application of sprinkler system designs through site surveys, testing sprinkler system components, and computer-aided analyses.

Life Safety Analysis

Life Safety Analysis (FPST 3143) introduces life safety concepts related to building codes, including means of egress design criteria and components, exits, component details, occupancy types, occupancy load, emergency lighting, marking of means of egress, evacuation movements, human performance capabilities, human response to fire cues, occupant pre-evacuation, and toxicology. The lab in this course emphasizes site surveys to see the building components, computer simulations on human behavior, and life safety code requirements applications.

Fire Dynamics

Fire Dynamics (FPST 3373) builds on the foundation principles of fluid mechanics. This course focuses on the fundamental thermodynamics of combustion, fire chemistry, and fire behavior. Here, students apply the fire behavior concepts in the lab and compare the theoretical equations to fire scenarios. This enables students to have a better understanding of fire spread and growth to be able to protect facilities better.

Industrial and Occupational Safety

The industrial safety track lab courses begin with *Industrial and Occupational Safety* (FPST 2023). The lab activities include an introduction to hazard identification and control processes and introductions to different industries via facility tours. At the end of the course, students can identify and classify common hazards in an industrial environment (including manufacturing, construction, and agricultural operations). Students will also be able to evaluate risks for severity and consequence, research regulatory and consensus standards for appropriate requirements and control methods, and develop mitigation and control strategies for identified hazards, including operational procedures and work methods to reduce hazards and risks.

Elements of Industrial Hygiene

Another lab class that provides an essential basis in safety and exposure sciences is *Elements of Industrial Hygiene* (FPST 2343). This course focuses on toxic or irritating substances and physical, biological, ergonomic, and other occupational stress factors that can cause an employee's illness or discomfort. It also highlights environmental pollution sources and controls. During lab activities, FPST students use physical instrumentation to assess the intensity of harmful noise, evaluate local exhaust ventilation, quantify ionizing and non-ionizing radiation sources, and measure flammable and toxic gas concentrations.

Safety, System and Process Safety Analysis

This course builds upon *Industrial and Occupational Safety, System and Process Safety Analysis* (FPST 4333), and utilizes fire and safety techniques to anticipate, recognize, and control hazards. Students learn process safety techniques like Fault Tree, HazOp, Failure Mode, and Effect Analysis. During lab activities, students use computer simulations, case studies, and site visits to apply these techniques to identify hazards or processes.

Risk Control Engineering

Both the safety and fire protection tracks culminate in *Risk Control Engineering* (FPST 4683). This lab course teaches the analysis of processes, equipment, facilities, and work practices for detecting and controlling potential hazards, evaluating risk, and developing risk control methodologies. Students perform tabletop exercises and site surveys to assess buildings and processes to understand risk compared to particular hazards that other courses focus on. Additionally, this course has multiple industry representatives who provide perspectives and approaches utilized within the industry.

ASSESSMENT

Assessment in these courses and the program consists of two levels: (a) the course-level student assessment through grading assignments and lab activities and (b) the ABET assessment of the program. Individual course assessment is completed through rubrics for written assignments, examinations, and lab practicals. Lab practicals include students demonstrating the taught skill, actively participating in the experience, or submitting lab reports. When assessing the program through ABET, the program focuses on the overall student outcomes required through the board. Yet, it can be built upon through course experiences, such as teamwork, communication, or understanding of technical areas. The ABET assessment uses rubrics to evaluate how well students achieve these outcomes toward the end of the program and make improvements.

In the spring of 2020, the program had to pivot quickly to make adjustments to lab activities being remote. Faculty worked with alums and known industry contacts to develop demonstration videos, virtual tours, and online experiences for the students. By the fall of 2020, our students were back on campus, and lab activities returned to normal, with added contingencies for moving back to virtual or handling isolations and quarantines of students. However, with these recent experiences, the program has seen an opportunity to advance experiential learning in virtual and online environments.

CONCLUSION

Looking to the future, the program is moving to online options to reach a broader student body, particularly those that may be considered non-traditional and cannot quickly move to a university to further their education. However, the lab experience is an essential aspect of the program.

Employers praise our graduates as ready to enter industry because of their experiential learning in the program. As such, laboratory activities in the virtual environment are a priority as the program moves into an online platform for the more non-traditional student. The use of augmented and virtual reality will be explored to immerse distance students in a lab experience fully. Compared to demonstration videos, this approach will allow students to have a similar experience to that of on-campus students.

Experiential learning is essential in students' understanding of practical field applications in fire protection, safety, and health. Additionally, this type of approach aids in students being able to not only understand the technical content but also grow in areas commonly assessed by ABET, like teamwork or communication, which may not be as quickly evaluated in the course-level assignments. However, as the world continues to evolve around us in the virtual environment, programs like FPST must continue to advance in these areas to meet the public's wants and needs for a higher education program. As such, future experiential learning must include both in-person and virtual experiences.

REFERENCES

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