Student Perceptions of Construction Site Safety and Achievement Goals in the Era of Digital and AI Technologies

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This pilot study investigates the intersection of learning theories and construction site safety awareness among undergraduate students in a construction management program. A survey, developed through interdisciplinary collaboration between the Departments of Civil Engineering and Construction Management and Child and Adolescent Development, was administered to 22 students enrolled in the construction management program and specifically in a construction site safety-focused laboratory course. In the context of post-pandemic conditions and emerging technologies, the study aims to identify key factors influencing students' perceptions of effective safety education. Additionally, the survey captured students' perspectives on the role of digital technologies like mobile phone applications, multiplayer game environments, and Artificial Intelligence (AI) in enhancing construction safety, revealing a divide between optimism and skepticism. Preliminary results suggest that students' achievement goals influenced how they interpret safety training methods and content as future construction professionals. This study lays the foundation for future research on comprehensive, technology-informed safety education strategies in construction and project management programs for a variety of learners.

Keywords: Construction Safety, Construction Management, Project Management, Construction Management Education, Growth Mindset, Artificial Intelligence

Introduction

Construction safety education and training are vital components for preparing professionals for the realities of job site hazards (Stuart, 2014). Despite ongoing efforts to improve safety outcomes in the workplace, the construction industry continues to report disproportionately high rates of injuries and fatalities, with workers being over five times more likely to be killed on the job compared to other sectors (Al-Bayati et al., 2023). While safety culture and climate in the workplace have emerged as important predictors of safety performance, their definitions and practical applications remain inconsistent across the industry (Schwatka et al., 2017; Zohar & Hofmann, 2014). These inconsistencies can be addressed earlier than reaching the workspace and specifically in educational settings, where students are just beginning to form their understanding of safety practices and responsibilities.

This pilot study explores how undergraduate students in a construction management program perceive construction site safety, particularly through the lens of personal and educational experiences. There is

very limited research focused on institutions that serve students from diverse cultural, socioeconomic, and familial backgrounds overall, and even less that addresses the specific needs of such students in construction management programs (Mosier et al., 2024). The research instrument (the survey) was developed through collaboration between faculty from the Department of Civil Engineering and Construction Management and the Department of Child and Adolescent Development. This partnership integrated perspectives from both technical and social or developmental disciplines to strengthen the research design. Such interdisciplinary faculty collaboration enhances research quality by promoting knowledge diffusion, cross-fertilization of ideas, and the synergistic creation of new insights, especially when researchers absorb and build upon each other's expertise (Bonaventura et al., 2017). Specifically, the survey was designed to assess students' achievement goals and safety awareness, with a focus on students' unique insights from lived experiences.

By examining students' educational goals and reflections of real-world injuries experienced by family members and friends in construction, this study aims to uncover how personal narratives may influence safety learning, an area that is largely unexplored in current construction safety education literature. The findings contribute to a growing body of research that calls for more context-sensitive approaches to safety education, ones that not only teach technical protocols but also acknowledge the lived experiences and aspirations of diverse student populations. In doing so, this work aligns with emerging frameworks that emphasize the role of individual actions and institutional commitment in shaping safety culture (Al-Bayati et al., 2019; Efremov, 2023).

Literature Review

Construction is consistently ranked among the most hazardous industries worldwide, making safety education a vital part of undergraduate curricula in construction management, project management, and engineering programs. Traditional methods such as Occupational Safety and Health Administration (OSHA) certification, lectures, and case studies, aim to improve hazard recognition and compliance, however, research shows that these approaches alone may not be sufficient to instill lasting safety values (Tixier et al. 2018), especially when disconnected from students' lived experiences or cultural contexts. Experiential learning strategies, such as site visits and simulations, have proven effective in helping students internalize safety concepts (Yu et al. 2022). For example, students who participated in real or virtual site visits demonstrated stronger understanding and engagement with safety practices compared to those who received only classroom instruction (Salman 2023). Research suggests that reflective and student-centered approaches, which acknowledge social and cultural contexts, can enhance learning experience and foster a stronger sense of ownership and professional attitude (Bhardwaj et al. 2025).

In addition to teaching strategies used, students' mindsets and views on achievement may also influence educational preferences and performance. Decades of developmental psychology and education research suggest that students' reactions to setbacks and learning outcomes are shaped by their achievement goals and implicit theories of intelligence, as either fixed or malleable (Dweck & Yeager, 2019). For example, task mastery (e.g., "I desire to completely master the material in this class") and competence performance goals ("I want to do well in this class to show my ability to my family, friends, advisors, or others") can lead to higher motivation and higher grades relative to fear of failure ("I want to avoid doing poorly in this class"; Elliot & Church, 1997). Interventions that promote student beliefs that intelligence can grow with effort and training (growth mindset) have had positive effects on academic achievement, persistence, and well-being (Burnett et al., 2022; Yeager et al., 2019).

Lastly, emerging digital technologies have expanded opportunities for construction safety training and enhanced capabilities for digital management, structural monitoring, real-time site monitoring, and hazard detection and prevention through tools such as Artificial Intelligence (AI), ChatGPT, conversational augmented reality (AR) systems, drones, smart sensors, and hazard detection algorithms (Fagarasian, 2025; Hussain et al., 2024; Lee & Lee, 2023; Maali et al., 2024; Rabbi & Jeelani, 2024; Uddin et al., 2023). Adoption of AI technologies since the launch of OpenAI in November 2022 has the potential to reduce workplace accidents by 35% (Fagarsian, 2025). However, legislative bodies and institutions of higher education are still exploring ways to implement AI, address ethical concerns, and minimize risks. There is evidence that AI can help customize learning experiences, break down challenging concepts for students, and improve short-term construction safety training learning outcomes, particularly for those with prior experience (Hussain et al., 2024; Uddin et al., 2023). The current study contributes to this growing literature by providing insights into how construction management college students themselves view these new tools, often as they are experiencing them for the first time in educational and professional settings.

Exploration of achievement mindset is limited in construction management. However, research of construction industry professionals suggests that growth mindset is correlated with democratic and transformative leadership styles that promote working toward common team goals (Owusu-Manu et al., 2021). Studies like these emphasize the importance of cultivating growth mindset among construction management students who will ultimately become the next generation of project managers. Therefore, the current study examines student achievement goals and perceptions of construction site safety education. Particularly, given the expansive ways that students can learn about construction site safety with new technologies, we further explore their perceptions of strategies in and out of the classroom as well as through digital tools (e.g., videos, multiplayer gaming environments, mobile phone applications, AI). These considerations are relevant when designing effective safety education strategies for a variety of learners.

Research Methodology

To investigate undergraduate students' perspectives on construction site safety education, the authors developed a survey instrument grounded in existing literature (e.g., achievement goals; Elliot & Church, 1997) and informed by interdisciplinary collaboration between experts in adolescent development and construction management. The research team brought complementary expertise: one focused on how social and cultural environments influence learning and behavior, particularly among underrepresented and first-generation youth, and the other specialized in construction industry practices and safety education.

The survey was administered to undergraduate students enrolled in a construction site safety laboratory course in a public university in California. The course primarily served lower-division students, including a mix of freshmen and juniors. Data collection was conducted at the end of the semester to ensure that students had adequate exposure to the course's subject matter, completed the OSHA-30 training and had developed rapport with the instructor, thereby increasing the likelihood of authentic and reflective responses.

A total of 22 undergraduate students completed the survey. Demographic information, academic level, and general background were collected to provide context for the analysis. Most students have lived in the United States for nearly two decades on average, though a few are more recent arrivals. Work experience in the U.S. varies, with some students having no experience and others reporting up to 20 years. English is the most common primary language, followed by Spanish and a few other languages. Many students are bilingual, with Spanish being the most frequent secondary language. Most rated

their language proficiency as excellent, though there was some variation in secondary language skills. As shown in Figure 1, the participant group was predominantly male at 82%, with female students representing 18%. The majority identified as Hispanic or Latina/o (77.4%), followed by Middle Eastern (9.1%), Black or African American (4.5%), Asian or Asian American (4.5%), and White or of European descent (4.5%). Approximately 87% of respondents reported that their parents had not pursued education beyond the primary or secondary level, highlighting a first-generation college student population. When asked about their career aspirations, 81% indicated a desire to become construction managers, while 19% expressed interest in project management roles. The figure below displays the demographics of the sample. The data were examined using descriptive methods to identify initial patterns and trends. Preliminary statistical analysis was also added to enhance the robustness of the findings. As this is a pilot study, only preliminary analyses were conducted; more detailed statistical analyses will require a larger dataset in future phases of the research.

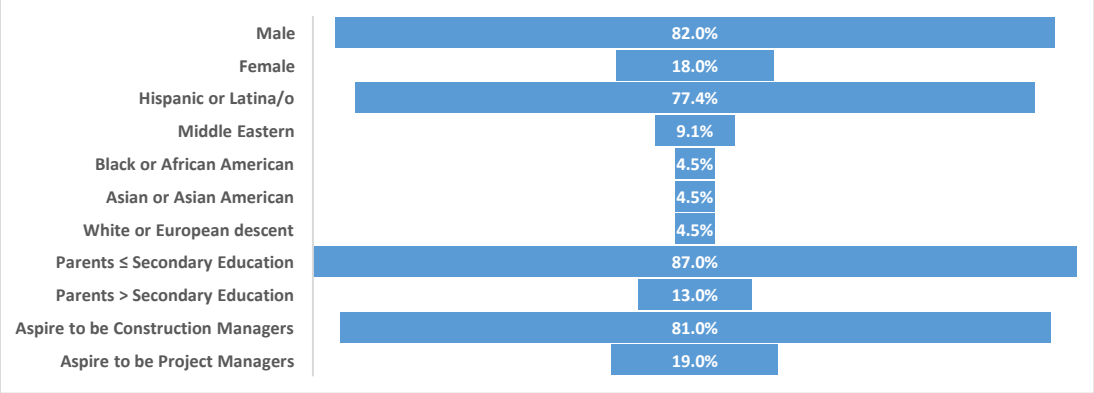

Figure 1. Demographic profile of surveyed undergraduate students (N=22)

The survey was designed to identify key factors influencing safety awareness and to capture the lived experiences of students exposed to construction safety education, both through formal training of the OSHA 30-hour program and through personal or familial connections to the industry. Given the limited prior research in this area, the survey adopted an exploratory approach. It included both structured and open-ended items to encourage student reflection on instructional content and real-world safety incidents.

Student perceptions of the importance in understanding construction site safety for their learning and development was assessed with 10 items and what can strengthen construction site safety education in their program was assessed with 9 items, both on a 5-point scale from 1 (not at all) to 5 (extremely important). Achievement goals assessed student mastery goals (e.g., “I desire to completely master the material in this class”), performance approach goals (“I want to do well in this class to show my ability to my family, friends, advisors, or others”), and performance avoidance goals (“I want to avoid doing poorly in this class”; Elliot & Church, 1997) on a 5-point scale from 1 (*strongly disagree*) to 5 (*strongly agree*).

Open-ended questions included those around knowing any friends or family members who have been injured as a result of construction work (“yes” or “no”), followed by “What happened? How do you feel about it?” Student perceptions of AI was assessed with the open-ended question: “In your opinion, can artificial technology play a role in enhancing safety in construction work? How can it help us?” In the survey, AI technology refers to “the ability of machines or computer programs to perform tasks that typically require human intelligence, such as learning, reasoning, problem-solving,

and decision-making." The survey instrument was pilot tested with one student to ensure clarity and usability prior to wider administration.

FINDINGS

Out of 12 students who responded to questions about their experience with construction site safety, 8 reported having relevant employment experience. These included internships, roles in construction or maintenance alongside family members, and jobs requiring safety awareness such as working in data centers or at a shooting range. Additionally, 6 students described extracurricular or synergistic activities that support safety-related skills. These ranged from set design and sports to volunteering, CPR certification, and community clean-up efforts. While not all students had direct construction experience, many demonstrated transferable skills and engagement in activities that contribute to a broader understanding of site safety.

Student Perspectives on Construction Safety Education and Achievement Goals

The student perspectives on effective methods for strengthening construction safety education are shown in Figure 2. The majority of students strongly agreed that direct, hands-on approaches, such as visiting construction fields, conversing with workers, and participating in safer work steps in the field, are most impactful. Technology-based methods, including mobile apps and virtual reality, received moderate support, while gamified environments and safety videos were viewed as supplementary. Overall, the findings highlight a clear preference for experiential and interaction-based learning over purely digital approaches.

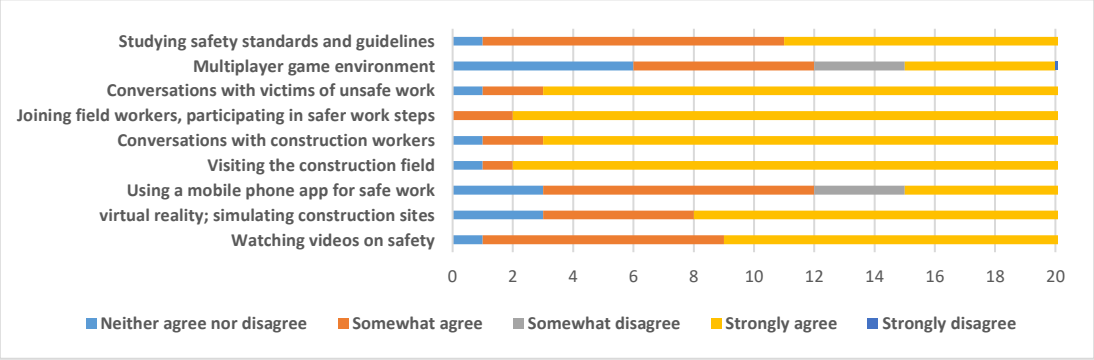

Figure 2. What Strengthens Construction Safety Education – Student Perspectives (N=22)

Figure 3 presents student ratings on the importance of site safety knowledge. OSHA training and certification, along with learning OSHA standards before graduation, were rated as extremely or very important by nearly all students, highlighting their central role in preparing future professionals. Internship experiences, mentorship by safety managers, and site visits were also strongly emphasized, reflecting the value of experiential learning. In contrast, reading books and traditional classroom lectures received more moderate importance ratings, suggesting students perceive them as supportive but less effective compared to practical exposure and applied training.

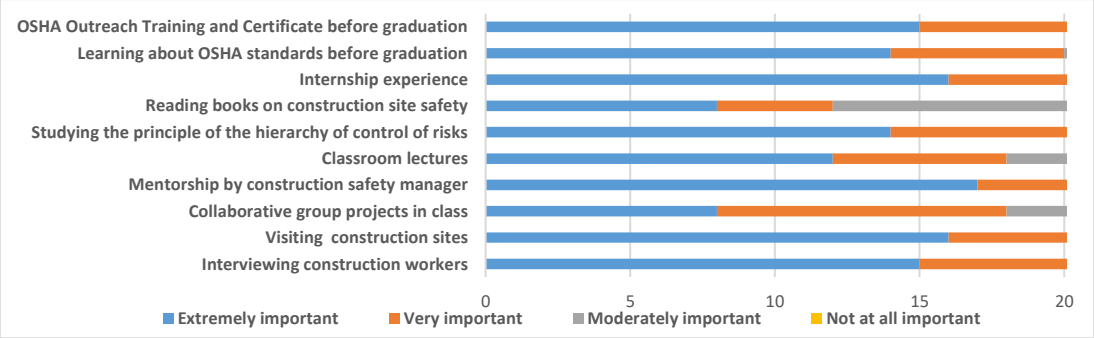

Figure 3. Student Ratings on the Importance of Site Safety Knowledge (N=22)

Student mindsets about their overall learning experience and future readiness from a construction management program are showcased through Figure 4. The majority of students strongly agreed that gaining deeper knowledge of construction safety, mastering class material, and learning as much as possible are central to their success, reflecting a strong intrinsic motivation. Curiosity-driven and challenging course material was also valued, showing student openness to rigor and engagement. Interestingly, some students indicated that fear of poor performance motivates them, while a smaller portion wished the class was not graded, highlighting mixed feelings about assessment. These results are aligned with research that suggests that students are less likely to endorse fear-based, performance-avoidance goals (e.g., "I wish this class was not graded") relative to task mastery and competence performance goals (Elliot & Church, 1997). Overall, the results suggest that students are primarily motivated by mastery and professional growth, with external factors like grades and recognition playing a secondary role.

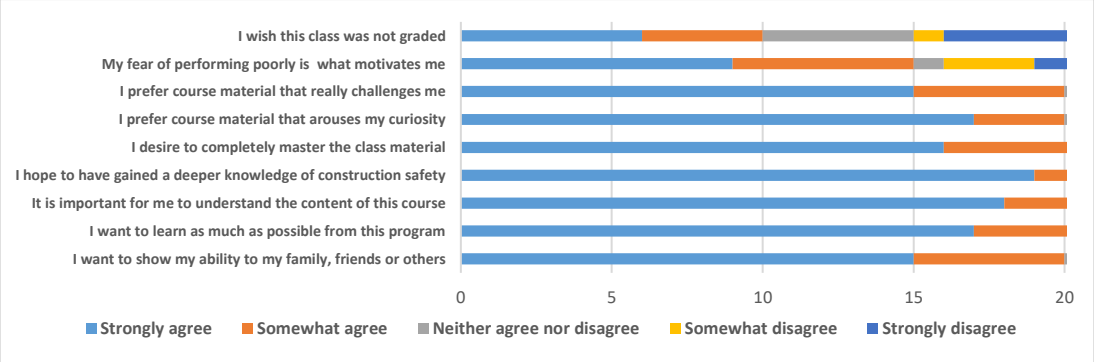

Figure 4. Student Mindset for Future Success in Construction Management (N=22)

As shown in Table 1, correlations between student mindsets and construction site safety knowledge variables demonstrate distinct profiles of preferences by learner (Table 1). Likely due to preferences for the class not to be graded, students who reported high performance avoidance goals were more likely to rate experiences outside the classroom (i.e., mentorship by a construction safety manager, internship experience) as more important to site safety knowledge and that the use of mobile phone applications would strengthen construction safety education in their program. Students who reported high mastery goals were more likely to report that a variety of site safety knowledge experiences would be important to and strengthen their learning (e.g., studying principles of hierarchy of control of risks, interviewing construction workers, visiting construction sites, OSHA training, classroom lectures, watching videos on safety). Finally, students who reported high performance approach goals

were more likely to focus on the importance of classroom lectures and OSHA standards during their time as students before graduation.

Table 1

Pearson Correlations Coefficients Between Study Variables

	Performance – Avoidance Goal	Mastery Goal	Performance – Approach Goal
What Strengthens Construction Safety Education			
Studying safety standards and guidelines	.35	**.50***	.25
Multiplayer game environment	.35	.21	-.08
Conversations with construction workers	-.03	**.59****	.20
Joining field workers, participating in safer work steps	.22	.40	.04
Conversations with victims of unsafe work	.26	.27	.05
Visiting the construction field	-.02	.31	.12
Using a mobile phone app for safe work	**.48***	.25	.15
Virtual reality; simulating construction sites	.17	.23	.24
Watching videos on safety	.30	**.48***	.23
Student Ratings on the Importance of Stie Safety Knowledge			
OSHA Outreach Training and Certificate before graduation	.03	**.59****	.32
Learning about OSHA standards before graduation	-.13	**.53***	**.52***
Internship experience	**.55****	.42	.16
Reading books on construction site safety	.00	.33	.16
Studying the principle of the hierarchy of control of risks	**.57****	**.50***	.39
Classroom lectures	.22	**.71*****	**.52***
Mentorship by construction safety manager	**.52***	.34	-.04
Collaborative group projects in class	.15	.20	-.07
Visiting construction sites	.35	**.45***	.20
Interviewing construction workers	.35	**.56****	.34

*$p < .05$. **$p < .01$. ***$p < .001$.

Though correlational rather than causal, these patterns suggest that students with growth mindset or higher mastery goals may be more open to a myriad of learning experiences and strategies. This is consistent with research that suggests intrinsic mastery motivation is associated with higher cognitive strategy use (e.g., rehearsal strategies, elaboration strategies, organizational strategies; Pintrich & De Groot, 1990). Alternatively, providing students with multiple opportunities for learning about construction site safety may cultivate a growth and mastery mindset. Mastery and performance approach goals can, in turn, be positively associated with academic outcomes (e.g., deeper processing, final grades, GPA; Alhadabi & Karpinski, 2020; Burnett et al., 2022; Coutinho & Neuman, 2008; Elliot & Church, 1997; Yeager et al., 2019). Learner mindset was not associated with reading books on construction site safety, collaborative projects, multiplayer game environments, or virtual reality methods. These strategies were rated lower in importance and in their ability to strengthen construction site safety by students in general.

Around half of the students (n = 11) reported having a family member or close friend who had experienced a construction-related injury. Descriptions of these incidents included falls from ladders, injuries from cutting equipment, burns from refrigerant gas, and being struck by falling objects. Some incidents were minor, but others involved severe outcomes such as broken bones or fatalities. Students were also asked about the perceived preventability of these injuries. Many indicated that improved safety precautions, training, communication, equipment security, proper use of personal protective equipment (PPE), and hazard awareness could have mitigated or prevented the accidents. Additional barriers such as lack of knowledge, language limitations, and failure to recognize risks were also identified as contributing factors. Furthermore, independent samples t-tests showed no significant differences between students who reported personal experience with a construction-related injury relative to those who did not in terms of what would strengthen construction safety education (ts(13-20) = -1.48 – 1.49, ps = .13 – 1.00), importance of safety site knowledge (ts(13-20) = -1.09 – 1.17, ps = .25 – 1.00), or achievement goals (ts(20) = -.62 - .63, ps = .54 - .76).

Student Perspectives on Artificial Intelligence (AI) in Construction Safety

In exploring students' views on the role of AI in construction safety ("Can Artificial Intelligence technology play a role in enhancing safety in construction work?"), responses revealed a near-even split between optimism and skepticism. Many students believed AI could play a valuable role in enhancing safety by simulating hazardous scenarios, automating high-risk tasks, and monitoring live job sites to predict and prevent accidents. "*I certainly think artificial intelligence could help enhance safety just because it's so powerful it could probably generate the 'what if' situations and eliminate them being that they're so hard to find.*" Others noted AI's potential for improving training through realistic simulations that help workers anticipate and avoid dangerous situations. "*I believe we can use AI to help come up with better solutions that we as humans cannot come up with. Or we can use it to simulate better training situations to prevent others from getting hurt.*" One student added, "*Maybe by monitoring a live feed of the site and predicting an outcome before it happens. It can sound an alarm if it thinks that something is about to happen or activate a kill switch.*"

On the other hand, several students expressed hesitation or concern about AI's role in safety-critical environments. Common themes included a lack of trust in AI decision-making, fears of job displacement, and the belief that safety requires human judgment and lived experience. "*Yes I believe that AI can play a tremendously huge role in safety construction, so much so that it'll take our jobs.*" Another student remarked, "*It can help make better decisions to approach a task, but the question would be if the worker could approach it safely and ethically. I would not trust the A.I.*" Some students felt AI lacked the emotional awareness necessary to fully understand safety, while a few dismissed its usefulness altogether. "*No they can't. These AI don't have feelings like us humans. They don't have feeling and don't know what safety is.*" One student summarized the tension: "*Yes because AI is way more smarter than us but at the same time no because it's not human and can't really determine human capabilities.*" Overall, while students acknowledged AI's potential in construction, their responses emphasized the importance of cautious, ethical, and human-centered implementation. These insights suggest that future safety education should address both the technological possibilities and the social implications of AI in construction.

Conclusion

Researchers from Construction Management, Civil Engineering, and Child and Adolescent Development collaborated to develop and administer a survey that captured undergraduate students' reflective narratives and experiences in how social, familial, and developmental contexts affect the learning of construction safety. Despite continued efforts to improve construction site safety, the

industry continues to suffer from high rates of on-site injuries and fatalities. For this pilot study, the authors focused on narratives from the undergraduate students who were exposed to the OSHA 30-hour training. In addition, this study gathered students' perspectives on digital technologies and AI and their capabilities to assist with construction safety.

Students reported that hands-on, interaction-based strategies were more effective relative to digital-based learning methods. Relatedly, students' perspectives on AI in construction safety were divided; although students believed AI could be helpful, many still expressed mistrust due to ethical and safety concerns. Active, experiential learning strategies (e.g., visiting a construction site, internship experience) were viewed as more effective for preparing students to become future professionals than passive strategies (e.g., classroom lectures). Results also revealed that the students were intrinsically motivated, and mastery motivation was associated with a variety of learning strategies. Pulling the results together, construction management educators should consider leveraging students' achievement goals and explicitly discussing the benefits and risks of AI and digital tools into their teaching materials.

Altogether, this paper contributes to the body of knowledge on students' perspectives on emerging digital technologies in construction site safety education and the effectiveness of experiential learning strategies for socially and academically motivated students at a Minority Serving Institution (MSI). The results, particularly the correlations, should be generalized with caution as the results are based on a small sample size from a single institution. However, future work can expand on the findings with a larger, national survey sample given global AI growth. As injuries and fatalities continue to plague the construction industry, research into improving safety training can play a critical role in finding scalable solutions.

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