Engineering Educators Bringing the World Together
2025 ASEE Annual Conference & Exposition
Palais des congrès de Montréal, Montréal, QC • June 22–25, 2025 ASEE
Paper ID #48490

Experiential Learning Activities: Building Grit and Driving Success Among Mechanical Engineering Graduates

Dr. Francisco J Montalvo, Purdue University

Francisco Montalvo is a Lecturer in the Design and Manufacturing area and the Assistant Director for Experiential Learning in the School of Mechanical Engineering at Purdue University. Francisco has contributed to experiential learning and diversity initiatives at Purdue University through project-based learning and international exchange programs. He co-led the Global Engineering Alliance for Research and Education (GEARE) program and is the co-founder of the Milestones micro-certification initiative, aimed at advancing hands-on, skills-based learning within the College of Engineering. In his current role, he teaches design courses and mentors industry-sponsored capstone projects while contributing to curricular development in the Design and Manufacturing area. With industry experience as a program manager for Siemens Professional Education in Germany, Francisco brings practical expertise and global awareness to his work.

Beth Hess, Purdue University
Lexy Chiwete Arinze, Purdue University at West Lafayette (COE)

Lexy Arinze is a first-generation PhD student in the School of Engineering Education at Purdue University and a Graduate Research Assistant with the Global Learning Initiatives for the Development of Engineers (GLIDE) research group. Lexy's research interests include early career engineers, Artificial Intelligence, experiential learning, and global experiences. He earned his master's degree in Civil Engineering from Purdue University. Before that, he received an Erasmus scholarship for an exchange program at the University of Jaén, Spain. He completed his undergraduate degree in Civil Engineering at the University of Ibadan, Nigeria.

Alanna Nash, Purdue University at West Lafayette (COE)

Experiential Learning Activities: Building Grit and Driving Success Among Mechanical Engineering Graduates

Abstract

Student engagement in Experiential Learning Activities (ELA) is typically correlated with improved post-graduation outcomes. Our School categorizes ELA into four areas: global (e.g., studying abroad), industrial (e.g., internships, co-ops), undergraduate research, and team projects. This study aimed to evaluate ELA participation and investigate the impact on post-graduation outcomes such as full-time employment and graduate school admissions. Additionally, a statistical analysis was conducted to assess the correlation between ELA participation and starting salary in industry placements. Our results show starting salaries increased with the number of ELA (i.e., students completing two or more ELA have higher salaries than those completing a single ELA). Students participating in undergraduate research were more than twice as likely to move on to graduate school than their peers. Students participating in industrial experiences were significantly more likely to have secured employment after graduation, and at a higher salary. This study provides key insights for curriculum development and institutional decision-making, demonstrating the value of prioritizing ELA to enhance student success. The findings from the study support the argument for embedding experiential learning opportunities in mechanical engineering curricula to improve student preparedness and improved long-term career outcomes.

Introduction

Experiential learning activities (ELA) such as studying abroad, internships, co-ops, undergraduate research, and team projects, have become integral components of many undergraduate engineering programs. These activities are highly effective methods for enabling students to bridge the gap between theoretical knowledge and practical, real-world applications. They are grounded in the perspective that learning is a holistic process encompassing all life experiences [1]. ELA provide students with superior learning outcomes, equipping them with industry-ready skills such as problem-solving, critical thinking, collaboration, and communication, all of which are highly valued by employers [2]. While the benefits of individual

ELA have been well-documented, there is little known about how the depth (measured by the number of semesters) and breadth (the variety of high-impact practices) of ELA participation influence students' post-graduation outcomes. Although studying individual ELA is valuable, it is essential to examine them collectively to quantitatively compare their impacts. This approach is especially important given that students have finite time and resources to explore their options.

Research on the impact of ELA , particularly for mechanical engineering students, has primarily focused on the learning outcomes, skills, and competencies these experiences help develop [3], [4], [5], [6]. Studies examining the influence of depth of participation in ELA have mostly explored the impact of individual type of experiences, finding that longer-term involvement is often more beneficial for learning outcomes and skill development [7], [8], [9], [10]. However, these individual ELA assessments provide limited opportunities for comparing experiences to identify the most effective approaches for preparing students for their post-graduation goals. Additionally, while fewer studies have evaluated the impact of breadth of ELA participation, findings suggest that engaging in a variety of ELA enhances interpersonal skills [11], and significantly predicts future career plans and early job attainment [12], [13]. These studies highlight the need for a more detailed understanding of the post-graduation outcomes associated with ELA participation.

The current study investigates how depth and breadth of participation in ELA influence post-graduation outcomes of mechanical engineering students. We collected data from 645 graduating seniors and analyzed them to understand the factors that impact graduation outcomes of students. Quantitative analysis investigated three research questions: RQ1: Which specific types of experiential learning activities lead to the greatest post-graduation outcomes when pursued in-depth? RQ2: Are there significant differences in postgraduation outcomes for students who emphasize depth versus breadth in their experiential learning activities? RQ3: How do the effects of depth and breadth in experiential learning differ across various demographic groups, such as gender, or ethnicity?

Our results indicate that completing two to three ELA result in the most favorable outcomes in terms of job offers, graduate school acceptance and overall success. Completing four or more

ELA on the other hand results in negative outcomes likely due to overexertion and Notably, students who completed no ELAs faced consistently negative outcomes, with job offers showing the steepest decline (-39.3%). However, completing four or more ELAs resulted in diminishing or negative returns for some outcomes, such as graduate school acceptance (-23.0%), likely due to overextension or a lack of focus on high-impact activities.

Background

ELA and mechanical engineering

Experiential learning, defined as learning through authentic, practice-based experiences, has been shown to enhance students' learning outcomes and the development of cognitive skills [4]. It is particularly relevant in the field of mechanical engineering, as it enables students to bridge the gap between theoretical knowledge and the practical skills required for their future careers [4], [5]. Research surrounding the impact of ELA, particularly for mechanical engineering students, has primarily focused on skill and competency development [3], [4], [6]. By engaging in hands-on projects and tackling real-world challenges, students develop a deeper understanding of the subject matter and gain the confidence to apply their knowledge in practical settings [4], [5]. While these experiences facilitate the integration of theory and practice, as well as skill development, further research is needed to better understand their impact on post-graduation outcomes.

Depth of ELA and Impact on Student Learning

We define depth as the duration of involvement in an ELA. Although a few studies have explored the impact of depth on student learning, most have focused on only one type of experiential learning activity rather than comparing different ELA within a single study. In the following sections, we review the literature on these different types of ELA with a focus on studies that explored the impacts of depth of participation.

Global experiences (e.g., studying abroad)

Research on the depth of study abroad has highlighted benefits associated with both long- and short-term programs. Some studies have shown that long-term study abroad experiences (typically a semester or longer) offer significant benefits in areas such as intercultural development, language acquisition, personal growth, global engagement, and more [9], [14], [15], [16], [17]. Conversely, other studies have demonstrated that short-term study abroad

programs can foster meaningful learning, global learning outcomes, and future international engagement [15], [18], [19]. Dwyer [15] examined 50 years of survey responses from study abroad participants and found that intensive summer programs of at least six weeks can have impacts on student learning but the greatest gains were observed among semester- and full-year students. Similarly, in a study of study abroad alumni spanning over 25 years, Hubbard & Rexeisen (2020) observed that while program length does not significantly influence students' attitudes toward global engagement, long-term programs are generally perceived by students as more valuable experiences than short-term programs. These studies show that although short-term programs offer some benefits, long-term programs yield stronger outcomes.

Industrial experiences (e.g., internships, co-ops),

Previous research on the duration of internships suggests that longer-term internships and placements have a greater impact on job acquisition after graduation and integration into the labor market [21], [22], [23]. In an exploratory study of internships at Greek universities, Mihail [22] observed that students regarded internship durations of four to six months as most beneficial to their productivity and value to employers. Mihail further suggested that internship periods ranging from six to twelve months would benefit both students and employing firms. A study conducted by Intern Bridge also found that students' satisfaction at the end of their internship experience was directly correlated with the duration of the internship [24]. The longer the duration of an internship, the greater the opportunity for development and the accumulation of knowledge, skills, and work experience [8], [25]. This effect of program duration also extends to co-operative education experiences.

Undergraduate research

Similar to industrial experiences, studies on the impact of depth in undergraduate research have shown that long-term experiences spanning multiple semesters are more beneficial than short-term ones [7], [26], [27], [28]. In their study assessing the impact of time on perceived gains from undergraduate experiences, Adedokun et al. [7] found that students reported significantly greater gains in numerous areas, particularly in research skills that require time to develop, at the end of a yearlong experience compared to a summer segment. Bauer & Bennett [26] also found a positive correlation between the number of semesters spent conducting undergraduate research and self-reported benefits. In another study, Craney et al. [27] found that students with longer undergraduate research experiences perceived their experiences as more beneficial for

employability and graduate school admission compared to those with shorter experiences. Similarly, Russell et al. [28] observed that the duration of undergraduate research positively influenced participants' interest in pursuing graduate school and research careers.

Team projects

There has been limited research on student team projects, with varying findings on the impact of duration. While exploring the impact of project duration on capstone design, Griffin et al. [29] found that one-semester capstone projects were more beneficial to both students and industry sponsors than two-semester projects and required fewer resources. In contrast, Keogh et al. [10] found that the scaffolding and support offered by year-long undergraduate team projects helps students develop their technical skills, communication abilities, teamwork, project management, and client negotiation skills, ultimately resulting in their growth into industry-ready graduates. The general trend in previous studies on the depth of individual ELA indicates that longer experiences yield greater benefits. However, these studies provide limited insight into how depth in one type of experience compares to others or which experiences offer the best post-graduation outcomes.

Breadth of ELA and impacts

We define breadth as the number of different ELA in which students participate. While several studies have examined the depth of various ELA, far fewer have focused on the breadth of these experiences. However, breadth has been suggested to hold significant value in terms of career development, skill competence, and personal growth [30], [31]. Coker et al. [11] conducted a five-year study of graduating seniors at Elon University, examining the impacts of the depth and breadth of ELA on student outcomes. They found that both factors led to significant learning gains for students. They further suggested that future research should investigate how these factors influence post-graduation outcomes. Twang [32] also examined the influence of ELA on post-graduation outcomes using graduates from a mid-sized public research university. The study found that field of study was an important predictor of post-graduate outcomes and suggested that future research analyze outcomes for students in specific degree fields for a more nuanced understanding of the influence of these experiences. Building on these studies, we explore the impact of depth and breadth on the post-graduation outcomes of mechanical engineering students.

Post-graduation outcome

The exploration of activities that influence post-graduation outcome of students is important because students often cite economic reasons as motivation for pursuing college degree [33]. While there has been significant research on the connection between students' involvement in diverse ELA on learning outcomes, skill and competence development, graduation rates and retention [31], [34], [35], [36], less research has been conducted to understand the impact of these activities on post-graduation outcomes. There is minimal literature examining which activities best assist students in achieving their post-graduate goals of either continued education or employment [12]. Previous studies have focused on the influence of individual ELA on the development of employability skills, post-graduation employment, length of time to job offer, starting salary, and the ability to work internationally [2], [37], [38], [39], [40]. While individual ELA exploration is valuable, collectively evaluating their impact is crucial, especially since students have limited time and resources to explore all available options.

Only a handful of studies have explored the collective effects of participating in ELA in relation to post-graduation outcomes. Miller et al. [13] examined the relationship between high-impact practices and post-graduation outcomes using data from the National Survey of Student Engagement (NSSE) and found that involvement in different types of experiential learning significantly predicts future career plans and early job attainment. In another study, Fowles [12] explored post-graduation outcomes by pairing the First Destination Survey (FDS)—an annual survey that captures what students are doing six months after graduation—with the activities they participated in during college, as collected by the NSSE. The study found a correlation between ELA and post-graduation outcomes, with graduates who did not complete an ELA being 98% more likely to still be seeking employment or continuing education compared to those who completed an ELA. The current study adds to the body of literature on ELA by exploring the impacts of depth and breadth of these activities on post-graduation outcomes particularly for mechanical engineering students. This work will further provide students with information about the optimum duration and combination of ELA that would most likely help them achieve their intended post-graduation outcome.

Research Methods

Data Collection

Data was collected via an online survey of every graduating senior over four semesters (Fall 2023, Spring 2024, Summer 2024, and Fall 2024).

The exit survey is a longstanding requirement for completing the Bachelor of Science in Mechanical Engineering (BSME) and is administered to graduating seniors during their final semester. Conducted every fall, spring, and summer session, the survey has been an integral component of the program's continuous improvement process, supporting ABET accreditation outcomes. It provides valuable feedback on program effectiveness, informs curriculum development, and offers critical insights into students' post-graduation trajectories, including employment, graduate school plans, and engagement in Experiential Learning Activities (ELAs). This ongoing data collection ensures that the program remains aligned with industry and educational standards while helping to shape strategies for enhancing student success.

Data Analysis

The first data analysis method was a preliminary search using Python to find any simple correlations between ELA completion and postgraduate outcomes. The four outcomes investigated were graduate school acceptance, job offers, salary of accepted job positions, and "success," a general term representing any student who secured either a job offer or a graduate school enrollment. To find complex relationships involving multiple variables, a gradient boosting machine learning model was developed on a subset of the data to predict the outcome of a student based on the input of which GRIT letters were completed. Multiple iterations of the model were trained on a random selection of 80% of the data and tested on the remaining 20%, with the highest-performing models used to output graphs explaining the relative importance of each ELA and combination thereof for each investigated outcome. To further investigate the effects of ELA depth on postgraduate outcomes, simplified charts were generated with less strict requirements for an ELA category to be considered completed, and the model's reactions were evaluated to determine the importance of ELA depth toward predicting outcomes. A random forest classification model was then used under the optimal ELA depth conditions to determine the relative importance of each ELA for predicting job, grad school, and success outcomes. Finally, the gradient model was applied to subsets of the data separated by nationality, gender, ethnicity, and graduation year, but none of these demographic categories yielded statistically significant differences in results.

Results

The heatmap on Figure 1 illustrates how the breadth of ELA participation (measured by the number of completed ELAs) impacts four key post-graduation outcomes: graduate school acceptance, job offers, overall success (securing a job or graduate school placement), and starting salary. The analysis revealed that students who completed two or three ELAs experienced the most positive outcomes. Specifically, two ELAs yielded the highest gains in job offers (+23.6%) and overall success (+12.9%), while three ELAs produced the greatest improvement in graduate school acceptance (+28.5%). Conversely, students with no ELA engagement experienced significant negative outcomes, particularly in job offers (-39.3%) and overall success (-37.8%). Interestingly, students who participated in four ELAs showed diminishing or negative returns in some areas, such as graduate school acceptance (-23.0%), suggesting that overloading on ELAs may detract from focus on impactful activities.

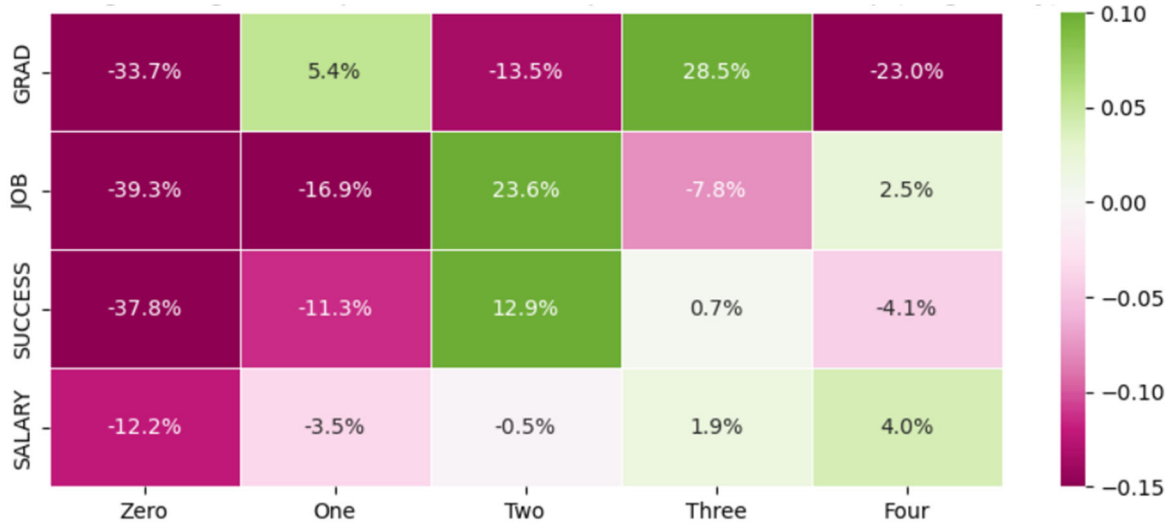

Figure 1: Heatmap of ELA Depth and Post-Graduation Outcomes

The following graphs display SHAP absolute feature importance for a random forest classifier model, which was utilized to analyze the relationship between various GRIT letters and the post-graduation outcomes. These feature importance charts highlight the relative absolute contribution of each GRIT letter to the model's predictions but do not indicate whether the impacts are positive or negative. The broader trends, however, are apparent and align with expectations from the data.

For JOB, industrial experiences (I) dominate as the most important feature, with a relative importance value of 0.7, much of which is likely positive. Research (R) follows distantly in

second place with a relative importance of 0.2, primarily reflecting a negative impact on job predictions. Global (G) and team-based (T) experiences have negligible influence, both contributing less than 0.1. In the case of GRAD, research (R) is the most influential feature, representing a strong positive predictor of graduate school acceptance, while industrial experiences (I) act as a significant negative factor, reversing the trend seen in the JOB predictions. Global (G) and team-based (T) experiences show slightly greater relative importance here, though this is likely because research does not dominate as overwhelmingly as industry does for JOB.

The results for SUCCESS offer a more nuanced perspective. Success, which includes both job offers and graduate school acceptance, suggests that global (G) and team-based (T) experiences play a relatively more prominent role compared to their influence in JOB or GRAD individually. This may result from the removal of the "push-pull" effect seen with research and industrial experiences in the separate job or graduate school analyses. Importantly, these feature importance graphs do not provide positive or negative associations for the features; they only indicate relative importance. For instance, global experiences (G) could contribute balanced positive and negative effects, while team experiences (T) may consistently provide smaller but uniform contributions. To explore the specific positive or negative impacts of these features, the colored SHAP summary graphs are critical in providing additional detail.

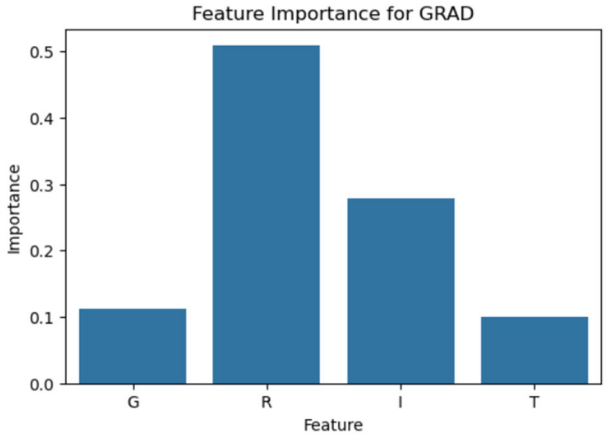

Figure 2: Feature Importance for Graduate School Acceptance (GRAD)

The feature importance analysis for graduate school acceptance, seen in Figure 2 highlights that undergraduate research (**R**) is the most significant predictor, with an importance score exceeding

0.5. Industrial experiences (I) were the second most impactful feature, contributing moderately to graduate school outcomes. In contrast, global (G) and team-based (T) activities had minimal influence, each contributing less than 0.15. These findings indicate that engaging in undergraduate research is a critical driver for students aspiring to pursue graduate studies, while industrial experiences provide additional but less prominent support.

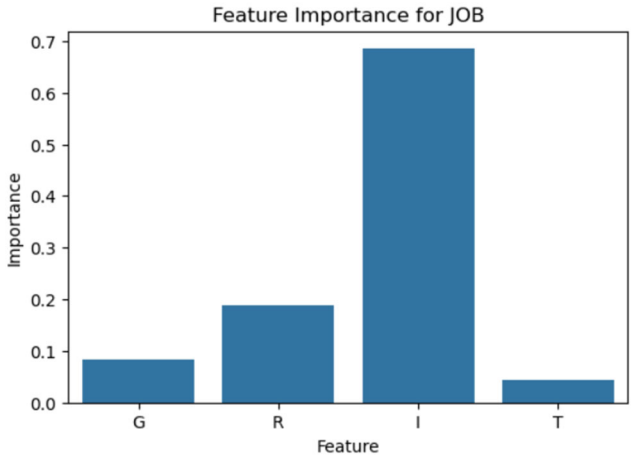

Figure 3: Feature Importance for Job Offers (JOB)

The feature importance analysis for job offers, as seen in Figure 3 reveals that industrial experiences (I) are the most significant predictor, with an importance score approaching 0.7. Research (R) is the second most impactful feature, contributing moderately to employment outcomes. Global (G) and team-based (T) activities had minimal influence, each scoring below 0.1. These results emphasize the critical role of industrial experiences, such as internships and co-ops, in preparing students for the job market and securing offers post-graduation.

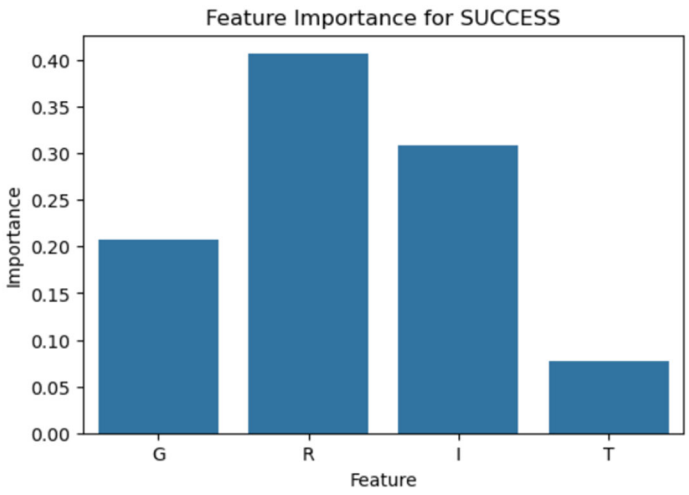

Figure 4: Feature Importance for SUCCESS

The feature importance analysis for overall success (securing either a job or graduate school placement) demonstrates that Research (R) is the most impactful ELA, with an importance score exceeding 0.4. This indicates that research activities are critical to achieving desirable post-graduation outcomes. Industrial experiences (I) follow closely, contributing significantly with a score of approximately 0.35, highlighting their strong role in preparing students for both employment and further education. Global experiences (G) provide additional support with a moderate score of 0.15, while team-based activities (T) contribute minimally, with an importance score below 0.05. These findings underscore the central role of research and industrial experiences in driving success, with global experiences providing supplementary benefits and team projects playing a smaller role.

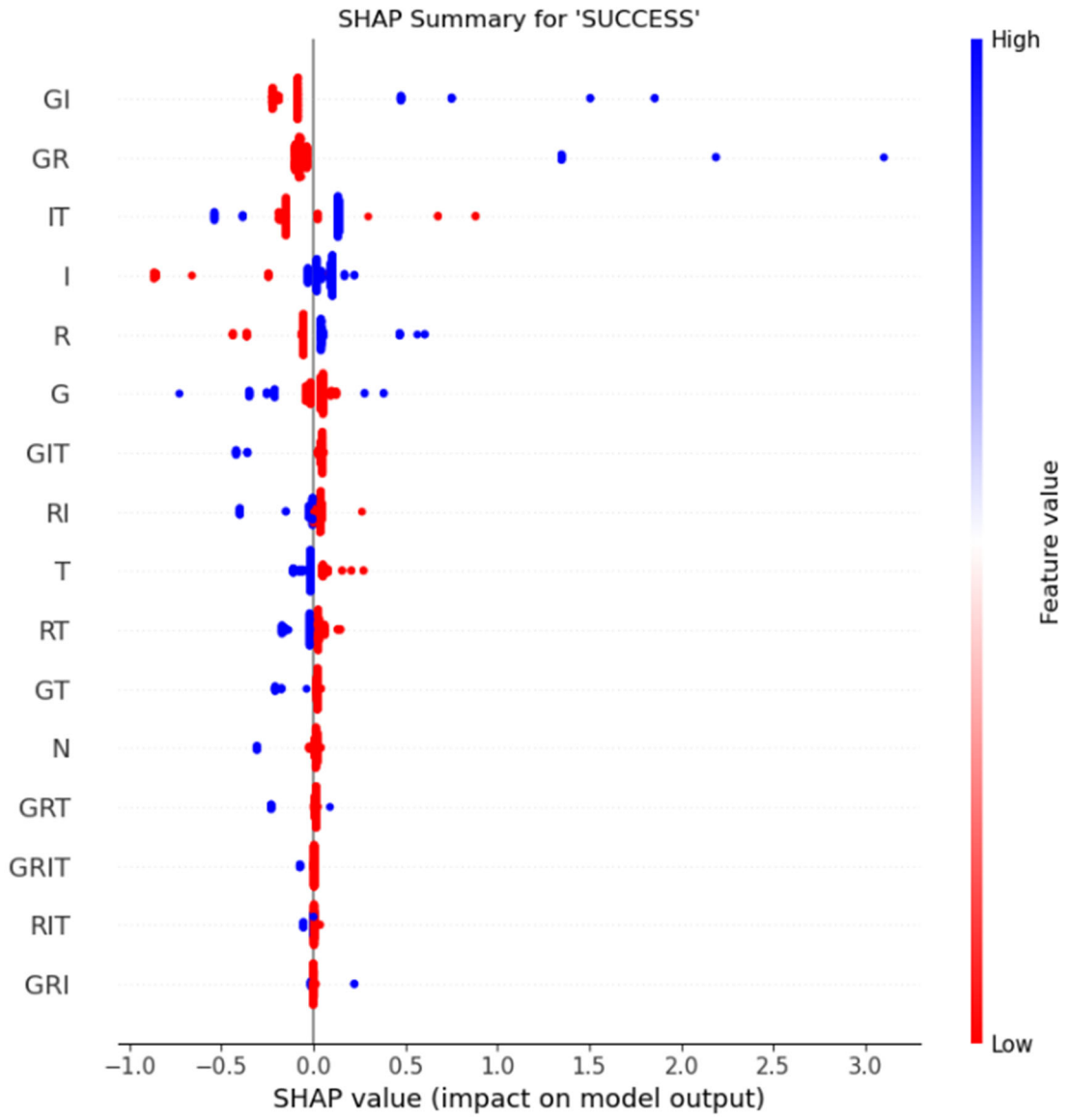

Figure 5: SHAP Summary for SUCCESS

The SHAP summary for success outcomes (job or graduate school placement) shown in Figure 5 provides further insights regarding the contribution of research (R) and industrial experiences (I) as the strongest contributors to overall success. Research activities exhibited consistently positive impacts, particularly for students with high engagement. Industrial experiences similarly supported success, while global (G) and team-based (T) activities had more variable effects. These findings highlight that research and industrial experiences play the most prominent roles in ensuring positive post-graduation outcomes, with other ELAs contributing to a lesser extent.

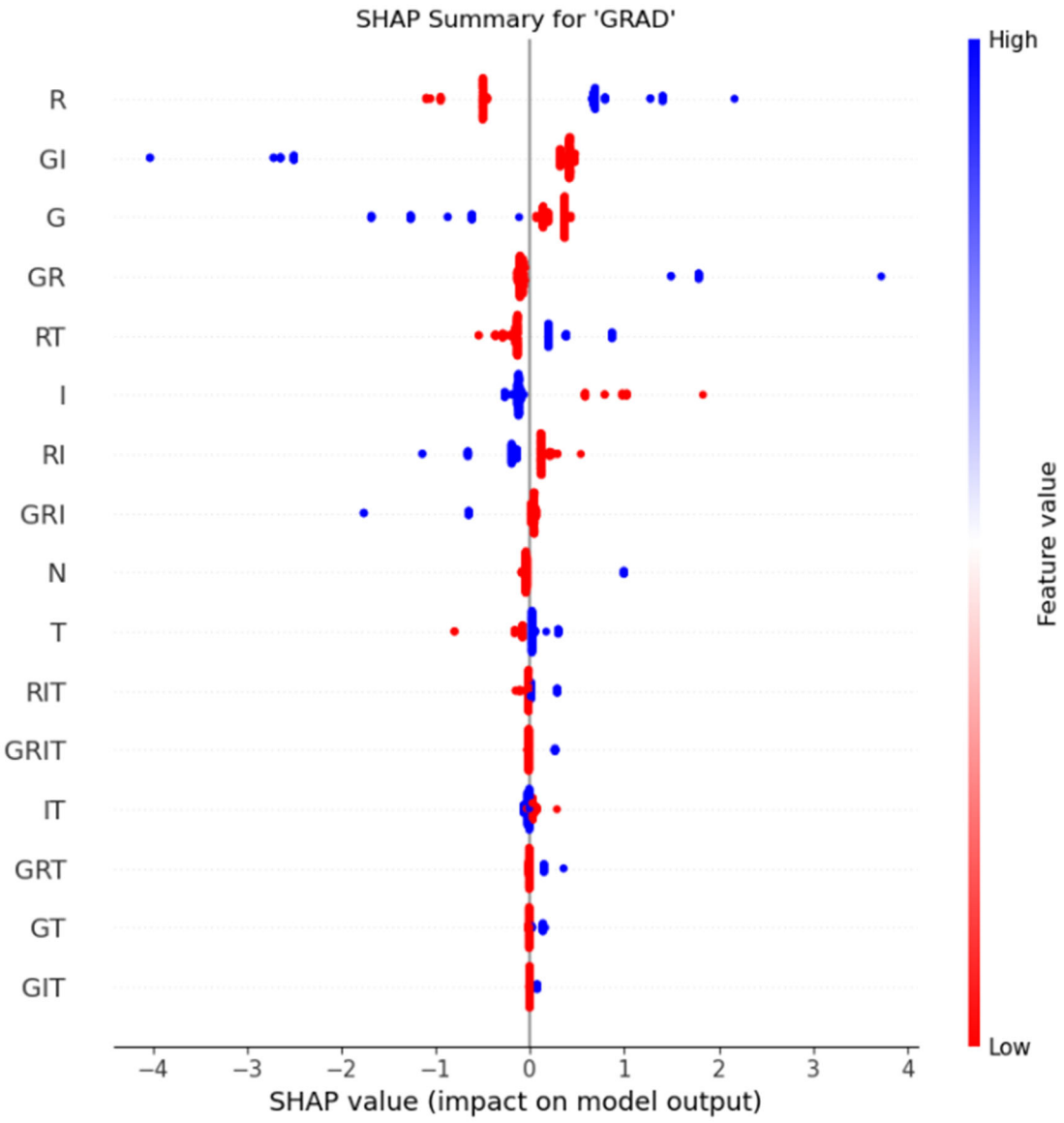

Figure 6: SHAP Summary for GRAD

The SHAP summary plot for graduate school acceptance shown in Figure 6 visualizes the impact of individual ELAs and their combinations on outcomes. Research-related activities (R) demonstrated the strongest positive contributions, both individually and in combinations such as global and research activities, labeled GR**.**

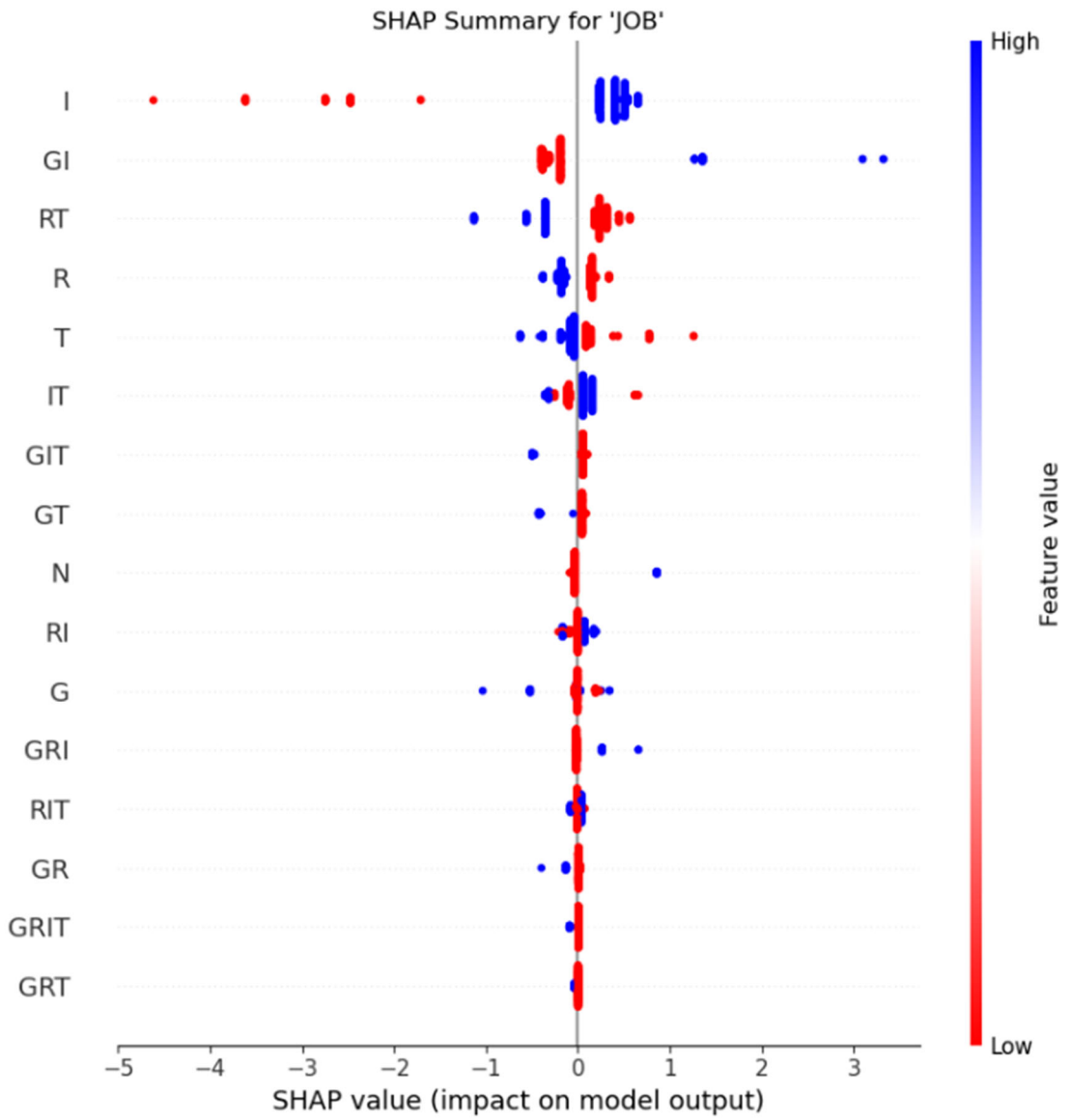

Figure 7: SHAP Summary for JOB

The feature importance analysis for job offers in Figure 7 reveals that industrial experiences (I) are the most significant predictor, with an importance score approaching 0.7. Research (R) is the second most impactful feature, contributing moderately to employment outcomes. Global (G) and team-based (T) activities had minimal influence, each scoring below 0.1. These results emphasize the critical role of industrial experiences, such as internships and co-ops, in preparing students for the job market and securing offers post-graduation.

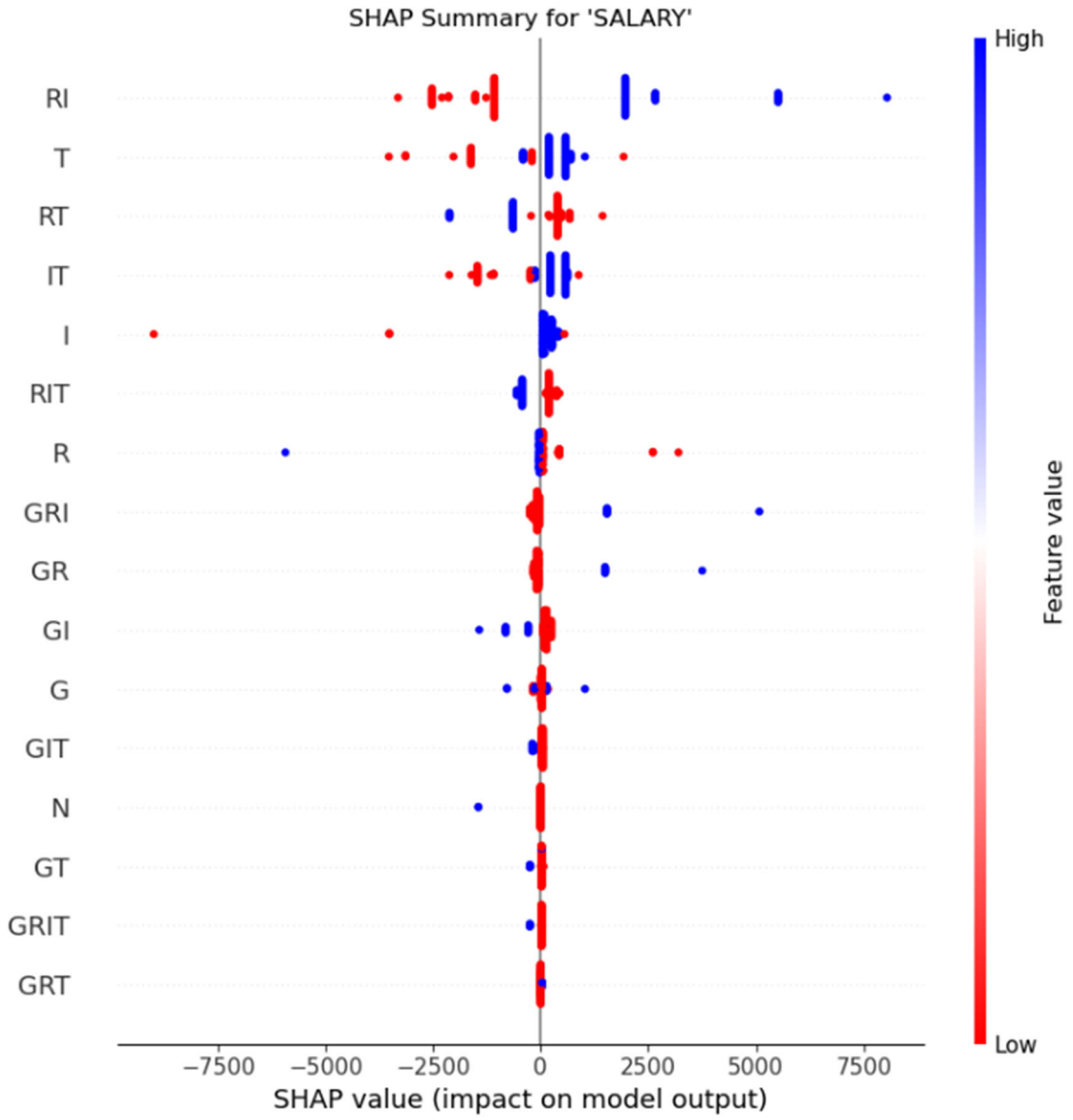

Figure 8: SHAP Value for SALARY

The SHAP summary for starting salaries shown in Figure 8 highlights the importance of industrial experiences, both individually (I) and in combination with other ELAs, such as research (RI) and team projects (RIT). Students engaged in these activities saw substantial positive impacts on predicted starting salaries. Conversely, students with minimal or no ELA engagement (N) experienced negative salary outcomes. Global experiences (G) and their combinations (e.g., GI, GR) had mixed effects, suggesting that their impact depends on how they are integrated with other ELAs or dependent on the duration and depth of the global experience. These findings demonstrate that industrial experiences are the most critical factor in achieving

higher starting salaries, with research playing a complementary role when combined strategically.

The Effect of Depth

To further refine the correlation with respect to global experiences (G) and their duration, two separate analysis were conducted filtering long global experiences, from all global experiences.

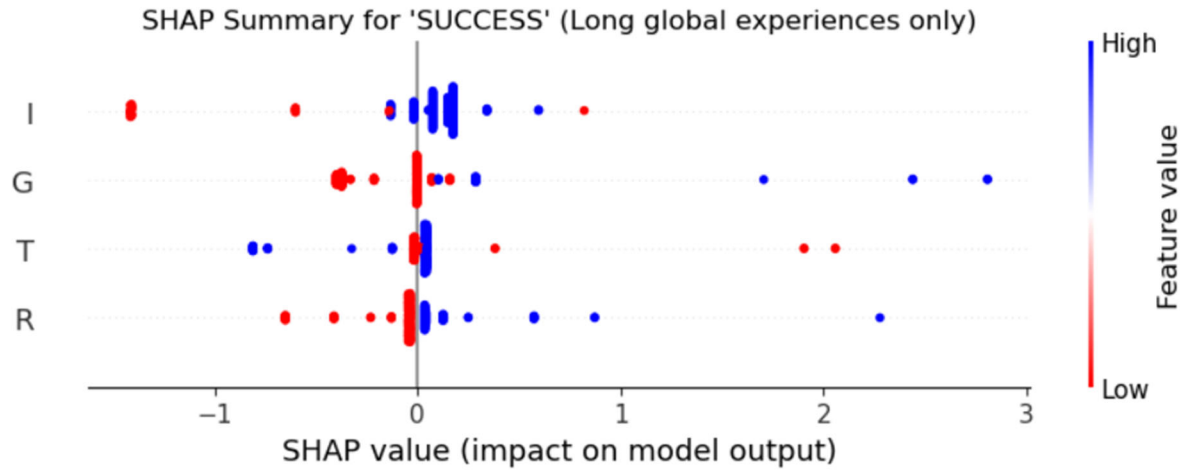

Figure 9: SHAP Summary for SUCCESS (Long global experiences only)

The purpose of these two graphs is to illustrate the impact of filtering out short-term experiences (less than 4 weeks of duration) from the analysis. In Figure 9, only long-term global experiences are included, making "G" one of the strongest and most easily identifiable predictors of post-graduation success.

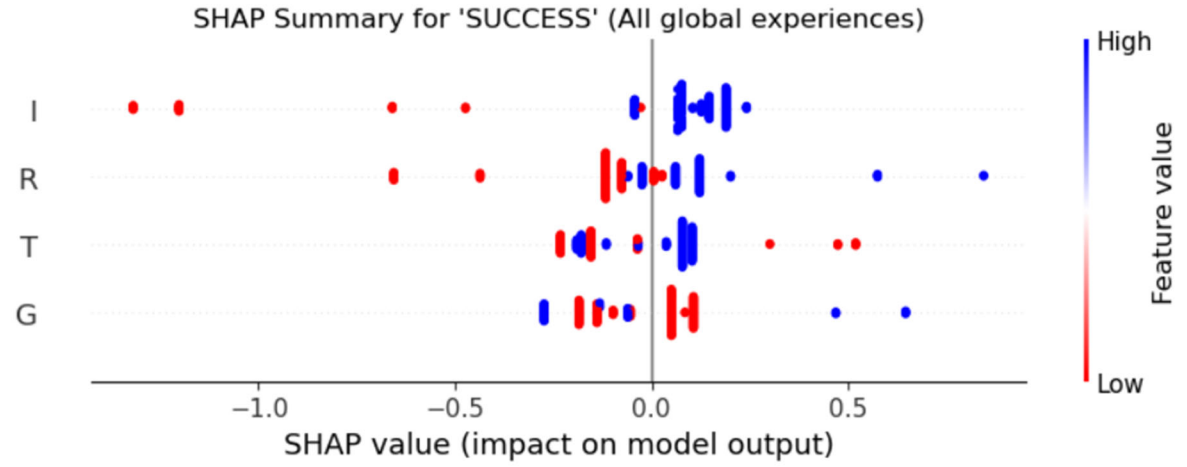

Figure 10: SHAP Summary for SUCCESS (All global experiences)

In contrast, the analysis shown in Figure 10 incorporates short-term global experiences, which significantly diminishes the predictive power of (G). Not only does (G) become the weakest predictor with the lowest average value, but the data also becomes more scattered, reducing the interpretability of other predictors like (R) and (T).
Applying relaxed thresholds for other ELA categories yields similar effects, but the distinction in global experiences (G) is the most recognizable. This pair of graphs provides compelling evidence for the importance of depth in Experiential Learning Activities (ELAs), emphasizing that meaningful, immersive experiences are key to driving student success.

Discussion

This study highlights the significant impact of Experiential Learning Activities (ELAs) on post-graduation outcomes for mechanical engineering students, emphasizing that the depth of these experiences is a key driver of success. While breadth, or diversity of ELAs, plays a role in certain outcomes, the results consistently show that deeper, more immersive experiences yield the most substantial benefits. The additional analysis of global experiences provides critical evidence supporting the idea that meaningful, long-term engagement is far more effective than shorter, unfocused participation.

Depth of ELA Engagement

The comparative analysis of global experiences clearly demonstrates the importance of duration in predicting success. When only long-term global experiences (greater than four weeks) are included in the model (Figure 9), G (Global experiences) emerges as one of the most impactful predictors of success. Students with deep, immersive global experiences benefit significantly, as shown by the clear clustering of positive SHAP values. These results suggest that longer global experiences offer transformative opportunities, likely by fostering additional skills such as intercultural competence, adaptability and resilience.
In contrast, the inclusion of both long- and short-term global experiences (Figure 10) significantly diminishes the predictive power of **G**. Short-term experiences reduce the overall contribution of global activities to success, with **G** becoming the weakest predictor and the data

showing greater scatter. This finding underscores the diluted impact of short-term or shallow participation, which may not allow students to fully engage or benefit from the experience. Additionally, the inclusion of short-term global experiences reduces the interpretability of other predictors, such as R (Research) and T (Team experiences)**,** highlighting how less impactful activities introduce noise into the analysis.

Breadth of ELA Engagement

The heatmap analysis revealed that completing two to three ELAs correlates with the most favorable outcomes. Students completing two ELA**s** experienced the highest increases in job offers (+23.6%) and overall success (+12.9%), while those completing three ELA**s** reported the most substantial improvement in graduate school acceptance (+28.5%). Notably, students who completed no ELAs faced consistently negative outcomes, with job offers showing the steepest decline (-39.3%). However, completing four or more ELAs resulted in diminishing or negative returns for some outcomes, such as graduate school acceptance (-23.0%), likely due to overextension or a lack of focus on high-impact activities.

The SHAP summary plots underscore the importance of specific ELAs and their combinations in driving success**.** Industrial experiences (I**)** emerged as the most critical predictor for securing job offers, with a feature importance score of nearly 0.7. Similarly, industrial experiences, when combined with other ELAs such as research (RI) or team projects (RIT), played a dominant role in predicting higher starting salaries. Research-related activities (R) were the strongest predictors of graduate school acceptance and contributed significantly to overall success. Global (G) and team-based (**T**) experiences, though valuable in specific combinations, exhibited more variable impacts when considered individually.

Starting Salary

The SHAP analysis for starting salary revealed that RI (Research + Industrial) and standalone I (Industrial experiences) had the most substantial positive contributions to salary predictions. Students engaged in industrial experiences consistently benefited from higher starting salaries, while research involvement amplified these benefits when combined with industrial activities. Combinations such as RIT (Research + Industrial + Team) and RT (Research + Team) also contributed positively, albeit to a lesser degree. Conversely, students with minimal or no ELA involvement (N) experienced predominantly negative impacts on predicted salaries. Global

experiences (G) and their combinations (e.g., GI, GR) provided mixed results, suggesting their influence on salary is highly context-dependent.

Implications for Curriculum Design

These findings provide actionable insights for curriculum development in mechanical engineering programs. Emphasizing industrial experiences, both as standalone opportunities and in combination with research activities, is crucial for preparing students for competitive job markets and maximizing their earning potential. Undergraduate research, while primarily beneficial for graduate school acceptance, also supports higher starting salaries when paired with industrial experiences. Institutions should also encourage a balanced portfolio of ELAs, ensuring students engage in at least two or three high-impact activities without overloading their schedules. Global and team-based experiences should be structured, when possible, to span multiple semesters, allowing students to engage deeply and gain substantial hands-on expertise. Clear curricular guidelines and targeted support for these opportunities can help students prioritize meaningful ELAs over short-term or superficial activities.

Demographic Consistency

The analysis revealed no statistically significant differences in ELA impacts based on demographic factors such as gender, ethnicity, or nationality. This suggests that the observed trends are broadly applicable across diverse student populations, reinforcing the universal value of ELAs for improving post-graduation outcomes.

Conclusion

This study underscores the significant influence of Experiential Learning Activities (ELA) on the post-graduation outcomes of mechanical engineering students, particularly when considering the depth and breadth of participation. The findings reveal that deeper engagement in fewer high-impact ELAs, such as industrial experiences or undergraduate research, yields better outcomes compared to superficial involvement in multiple activities. Students who completed two or three ELAs demonstrated the highest rates of job placement, graduate school acceptance, and starting salary increases, highlighting the importance of prioritizing meaningful and immersive experiences.

Additionally, the results emphasize the role of tailored ELA programs in preparing students for specific career pathways. Industrial experiences were the strongest predictor of job acquisition and higher salaries, while undergraduate research emerged as critical for graduate school admission. Although global and team-based experiences played smaller roles overall, their strategic integration with other ELAs demonstrated supplementary benefits. These insights advocate for mechanical engineering curricula that balance targeted depth and strategic breadth to optimize student outcomes.

Overall, this research contributes to the growing body of evidence supporting the integration of experiential learning into undergraduate education. It also provides actionable recommendations for curriculum developers, and administration in higher education institutions to enhance the employability and educational advancement of engineering students.

Limitations

This study has several limitations that should be considered when interpreting the results. First, the dataset relied on self-reported survey data, which may introduce biases such as overestimation or underestimation of ELA participation and outcomes. Additionally, the analysis did not account for external variables such as regional job market conditions, institutional resources, or differences in ELA quality, which may influence post-graduation outcomes.

Second, the study focused on mechanical engineering students at a single institution, limiting the generalizability of the findings to other engineering disciplines or universities. Future research could expand the scope to include diverse student populations and institutional contexts.

Third, while the study explored the depth and breadth of ELA participation, it did not investigate the specific timing, sequencing, or intensity of these experiences, which could further influence their effectiveness. Understanding how these factors interplay over time would provide more comprehensive insights.

Lastly, the study excluded qualitative perspectives, such as student reflections or employer feedback, that could offer deeper insights into the nuances of ELA impacts. Incorporating mixed methods in future research could address this gap and provide a more holistic understanding of the role of experiential learning in shaping student success.

Future Work

Future studies on the impact of the depth and breadth of ELAs, particularly on post-graduation outcomes, would be valuable for undergraduate students as they navigate their studies and engage in activities aimed at achieving their post-graduation goals. Understanding the extent to which ELA depth and breadth predict employment or continued education rates within six months of graduation, while controlling for other relevant factors, would be especially beneficial. Additionally, it would be useful to examine how the order in which diverse experiential learning activities are undertaken affects their cumulative impact on post-graduation outcomes.

References

[1] D. A. Kolb, *Experiential learning: Experience as the source of learning and development*. FT press, 2014.

[2] J. E. Crossman and M. Clarke, "International experience and graduate employability: stakeholder perceptions on the connection," *High. Educ.*, vol. 59, no. 5, pp. 599–613, May 2010, doi: 10.1007/s10734-009-9268-z.

[3] H. Li, A. Öchsner, and W. Hall, "Application of experiential learning to improve student engagement and experience in a mechanical engineering course," *Eur. J. Eng. Educ.*, vol. 44, no. 3, pp. 283–293, May 2019, doi: 10.1080/03043797.2017.1402864.

[4] S. F. Pamungkas, I. Widiastuti, and Suharno, "Kolb's experiential learning for vocational education in mechanical engineering: A review," *AIP Conf. Proc.*, vol. 2114, no. 1, p. 030023, Jun. 2019, doi: 10.1063/1.5112427.

[5] S. F. Pamungkas, I. Widiastuti, and Suharno, "Vocational Student's Attitude and Response Towards Experiential Learning in Mechanical Engineering," *Open Eng.*, vol. 11, no. 1, pp. 254–268, Jan. 2021, doi: 10.1515/eng-2021-0027.

[6] C. A. Sanchez-Gomez, "Implementing a joint learning method (PBL and EBL) to innovate the development of mechanical engineering technical and non-technical skills," *Int. J. Mech. Eng. Educ.*, vol. 50, no. 1, pp. 176–196, Jan. 2022, doi: 10.1177/0306419020950751.

[7] O. A. Adedokun *et al.*, "Effect of Time on Perceived Gains from an Undergraduate Research Program," *CBE—Life Sci. Educ.*, vol. 13, no. 1, pp. 139–148, Mar. 2014, doi: 10.1187/cbe.13-03-0045.

[8] P. Comyn and L. Brewer, “Does work-based learning facilitate transitions to decent work?,” International Labour Organization, 2018.

[9] E. C. Ingraham and D. L. Peterson, “Assessing the impact of study abroad on student learning at Michigan State University,” *Front. Interdiscip. J. Study Abroad*, vol. 10, no. 1, Art. no. 1, Aug. 2004, doi: 10.36366/frontiers.v10i1.134.

[10] K. Keogh, L. Sterling, and A. T. Venables, “A scalable and portable structure or conducting successful year-long undergraduate software team projects,” *J. Inf. Technol. Educ. Res.*, vol. 6, no. 1, pp. 515–540, Jan. 2007.

[11] J. S. Coker, E. Heiser, L. Taylor, and C. Book, “Impacts of experiential learning depth and breadth on student outcomes,” *J. Exp. Educ.*, vol. 40, no. 1, pp. 5–23, Mar. 2017, doi: 10.1177/1053825916678265.

[12] M. Fowles, “The Relationship between Internships, Study Abroad, and Undergraduate Research and Post-Graduation Outcomes,” Ed.D., University of Kansas, United States -- Kansas, 2022. Accessed: Dec. 10, 2024. [Online]. Available: https://www.proquest.com/docview/2681506890/abstract/AFC1BF6F21C943B3PQ/1

[13] A. L. Miller, L. M. Rocconi, and A. D. Dumford, “Focus on the finish line: Does high-impact practice participation influence career plans and early job attainment?,” *High. Educ.*, vol. 75, pp. 489–506, 2018.

[14] J. S. Coker, E. Heiser, and L. Taylor, “Student outcomes associated with short-term and semester study abroad programs,” *Front. Interdiscip. J. Study Abroad*, vol. 30, no. 2, pp. 92–105, Apr. 2018.

[15] M. M. Dwyer, “More Is Better: The Impact of Study Abroad Program Duration,” *Front. Interdiscip. J. Study Abroad*, vol. 10, no. 1, pp. 151–164, Aug. 2004, doi: 10.36366/frontiers.v10i1.139.

[16] K. Kehl and J. Morris, “Differences in global-mindedness between short-term and semester-long study abroad participants,” *Front. Interdiscip. J. Study Abroad*, vol. 15, no. 1, pp. 67–80, 2007.

[17] R. M. Paige, G. W. Fry, E. M. Stallman, J. Josić, and J. Jon, “Study abroad for global engagement: the long-term impact of mobility experiences,” *Intercult. Educ.*, vol. 20, no. sup1, pp. S29–S44, Jan. 2009, doi: 10.1080/14675980903370847.

[18] J. G. Hunter, C. A. Mattson, and S. P. Magleby, “Benefits of a short-term engineering study abroad: a survey of students over the past 15 years,” in *Volume 3: 21st International Conference on Advanced Vehicle Technologies; 16th International Conference on Design Education*, Anaheim, California, USA: American Society of Mechanical Engineers, Aug. 2019, p. V003T04A018. doi: 10.1115/DETC2019-98419.

[19] D. B. Knight, K. A. Davis, T. J. Kinoshita, C. Twyman, and A. M. Ogilvie, “The Rising Sophomore Abroad Program: Early Experiential Learning in Global Engineering,” *Adv. Eng. Educ.*, 2019, Accessed: Dec. 10, 2024. [Online]. Available: https://eric.ed.gov/?id=EJ1236917

[20] A. Hubbard and R. J. Rexeisen, “Study abroad and cultural immersion: an alumni retrospect,” *Intercult. Educ.*, vol. 31, no. 3, pp. 345–358, May 2020, doi: 10.1080/14675986.2020.1728500.

[21] M. Hall, H. Higson, and N. Bullivant, “The role of the undergraduate work placement in developing employment competences: Results from a 5 year study of employers,” presented at the DECOWE International Conference, 2009, pp. 24–26.

[22] D. M. Mihail, “Internships at Greek universities: an exploratory study,” *J. Workplace Learn.*, vol. 18, no. 1, pp. 28–41, 2006.

[23] N. O’Higgins and L. P. Caro, “What makes for a’good’internship?,” *Internsh. Employab. Search Decent Work Exp.*, pp. 35–54, 2021.

[24] A. Grasgreen, “Résumé-builder or rip-off? Insider Higher Ed,” 2012.

[25] E. Berntson, M. Sverke, and S. Marklund, “Predicting perceived employability: human capital or labour market opportunities?,” *Econ. Ind. Democr.*, vol. 27, no. 2, pp. 223–244, 2006.

[26] K. W. Bauer and J. S. Bennett, “Alumni perceptions used to assess undergraduate research experience,” *J. High. Educ.*, vol. 74, no. 2, pp. 210–230, 2003.

[27] C. Craney, T. McKay, A. Mazzeo, J. Morris, C. Prigodich, and R. De Groot, “Cross-discipline perceptions of the undergraduate research experience,” *J. High. Educ.*, vol. 82, no. 1, pp. 92–113, 2011.

[28] S. H. Russell, M. P. Hancock, and J. McCullough, “Benefits of undergraduate research experiences,” *Science*, vol. 316, no. 5824, pp. 548–549, 2007.

[29] P. M. Griffin, S. O. Griffin, and D. C. Llewellyn, “The impact of group size and project duration on capstone design,” *J. Eng. Educ.*, vol. 93, no. 3, pp. 185–193, 2004, doi: 10.1002/j.2168-9830.2004.tb00805.x.

[30] J. S. Coker and D. J. Porter, “Maximizing experiential learning for student success,” *Change Mag. High. Learn.*, vol. 47, no. 1, pp. 66–72, 2015.

[31] A. Finley and T. McNair, “Assessing underserved students’ engagement in high-impact practices,” 2013.

[32] A. Twang, “High-Impact Learning Experiences and Post-Graduate Outcomes: Exploring the Influence on Employment, Continuing Education and Salary,” *SUNY J. Scholarsh. Engagem. JoSE*, vol. 2, no. 1, Nov. 2022, [Online]. Available: https://digitalcommons.cortland.edu/jose/vol2/iss1/2

[33] E. B. Stolzenberg *et al.*, “The American freshman: National norms fall 2019,” *High. Educ. Res. Inst. UCLA*, vol. 42, 2020.

[34] C. A. Kilgo, J. K. Ezell Sheets, and E. T. Pascarella, “The link between high-impact practices and student learning: Some longitudinal evidence,” *High. Educ.*, vol. 69, pp. 509–525, 2015.

[35] G. D. Kuh, “High-impact educational practices: What they are, who has access to them, and why they matter,” American Association of Colleges and Universities, Washington, D.C., 2008. [Online]. Available: https://www.aacu.org/node/4084

[36] M. J. Mayhew, A. N. Rockenbach, N. A. Bowman, T. A. Seifert, and G. C. Wolniak, *How college affects students: 21st century evidence that higher education works*, vol. 1. John Wiley & Sons, 2016.

[37] R. Huang and R. Turner, “International experience, universities support and graduate employability – perceptions of Chinese international students studying in UK universities,” *J. Educ. Work*, vol. 31, no. 2, pp. 175–189, Feb. 2018, doi: 10.1080/13639080.2018.1436751.

[38] J. B. Main, B. N. Johnson, and Y. Wang, “Gatekeepers of Engineering Workforce Diversity? The Academic and Employment Returns to Student Participation in Voluntary Cooperative Education Programs,” *Res. High. Educ.*, vol. 62, no. 4, pp. 448–477, Jun. 2021, doi: 10.1007/s11162-020-09596-7.

[39] C. K. Mears, “Internships and post-graduation employment,” 2019.

[40] C. Yarbrough, “STEM students go abroad for research and internships,” *Int. Educ.*, vol. 25, no. 2, p. 44, 2016.