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Enhancing Engineering Students' Soft Skills Through Project-Based Learning: Al-Maarefa University Survey

Moath Alatefi
Industrial Engineering Department
College of Engineering, King Saud University
P.O. Box 800, 11421 Riyadh, Saudi Arabia
Malatefi@ksu.edu.sa

Sultan M. M. Almutairi and Malek AlMobarek
Industrial Engineering Department
AlMaarefa University, Riyadh, P.O. Box 71666, Riyadh 11597
Kingdom of Saudi Arabia
smutairi@um.edu.sa, mmobarek@um.edu.sa

Abstract

Soft skills such as teamwork, communication, leadership, time management, and problem-solving are increasingly recognized as essential competencies for engineering graduates, yet traditional lecture-based instruction offers limited opportunities for their systematic development. This study examines students' perceptions of soft-skill development within a structured Project-Based Learning (PBL) approach implemented in Industrial Engineering courses at Al-Maarefa University. The PBL model incorporated defined project phases, instructor monitoring, and formal reporting. Students' perceptions were measured using a questionnaire covering six soft-skill constructs and overall PBL perception. Data were analyzed using descriptive statistics, reliability analysis, one-sample t-tests, and exploratory nonparametric group comparisons. The results indicate generally positive perceptions, particularly for time management, teamwork, and communication skills, while leadership, problem-solving, and presentation skills were rated more neutrally. Exploratory analysis revealed a statistically significant difference in time management perceptions across GPA levels, with no consistent differences across academic level or gender. These findings provide empirical evidence on the role of structured PBL in supporting selected professional skills in Industrial Engineering education and identify areas for instructional refinement.

Keywords

Project-Based Learning, Soft Skills Development, Industrial Engineering Education, Outcomes-Based Education and Statistical analysis.

1. Introduction and Literature Review

Engineering employers increasingly emphasize graduate readiness beyond technical competence. Alongside analytical and domain knowledge, organizations expect engineers to communicate effectively, collaborate in multidisciplinary teams, manage time and resources, and demonstrate leadership and professional responsibility (Afroze et al., 2019). These competencies—often referred to as "soft skills" or professional skills—are repeatedly identified as critical determinants of employability and early-career performance, particularly in roles that require coordination across functions, stakeholder engagement, and structured problem solving (Musa et al., 2025, Pandey et al., 2024, Mohammad, 2025). In the context of Industrial Engineering (IE), this emphasis is even more pronounced, as IE

graduates frequently operate at the interface of technical systems and human–organizational systems (Mekitiak, 2009), where outcomes depend on teamwork, communication, and decision-making under constraints.

Despite their importance, soft skills are not consistently developed through conventional lecture-centric instruction (Hora et al., 2018). Moreover, when soft skills are included, they are sometimes treated implicitly rather than through explicit learning objectives, structured learning activities, and transparent assessment. This gap motivates the adoption of educational approaches that embed professional skill development within the core of engineering coursework. In this regard, project-based learning (PBL) has been widely proposed as an effective educational strategy for bridging this gap (Almulla, 2020). In PBL, students learn by engaging in projects that require them to define problems, plan tasks, allocate responsibilities, develop and test solutions, and communicate results. In engineering education, PBL is frequently associated with improvements in engagement and perceived learning, and it is commonly used to promote higher-order cognitive outcomes such as analysis, evaluation, and design (Sukackė et al., 2022). Importantly, PBL environments provide a natural setting for cultivating soft skills because project work requires sustained collaboration, iterative communication, and shared accountability.

Structured PBL integrates explicit project phases, scheduled checkpoints, defined roles, peer assessment mechanisms, and rubric-based evaluation. Such structure can improve fairness and accountability, and it increases the likelihood that targeted soft skills are practiced repeatedly and assessed consistently. From a systems perspective, structured PBL functions as a designed process with defined inputs (project tasks, team composition, guidance), controls (milestones, feedback loops), and outputs (deliverables, demonstrated competencies), making it amenable to continuous improvement—an approach naturally aligned with IE principles (Sánchez-García and Reyes-de-Cózar, 2025). In addition to industry expectations, engineering programs often operate under outcomes-based education models and accreditation requirements. Accreditation frameworks require evidence that students can function effectively on teams, apply engineering design (Qadir et al., 2020). As a result, engineering departments increasingly seek instructional designs and assessment systems that can generate credible evidence of these outcomes.

While the global literature supports the value of PBL, there remains a need for institution-specific evidence, particularly within GCC higher education contexts. For Al-Maarefa University, where Industrial Engineering education is developing within a competitive environment, establishing evidence-based teaching practices that improve graduate readiness is particularly relevant.

Accordingly, this study examines whether a structured PBL model can enhance self-reported soft skills among Industrial Engineering students at Al-Maarefa University. The study implements a structured project design, then evaluates perceived changes in key skill domains including teamwork, communication, time management, leadership, and problem solving through a questionnaire-based assessment. This work provides empirical evidence on soft-skill development linked to structured PBL in a GCC university setting.

2. Methodology

This study adopted a structured research methodology consisting of three main stages First, implementation of a structured Project-Based Learning (PBL) model, second questionnaire design for measuring soft-skill dimensions, and third, data analysis. The overall research framework is illustrated in Figure 1.

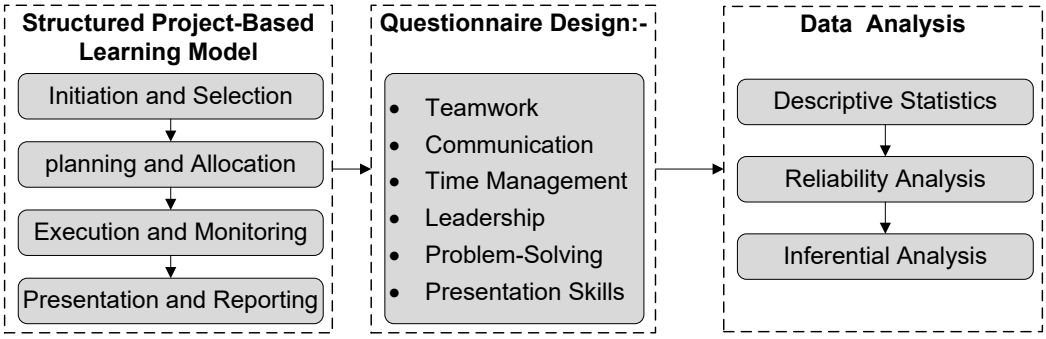

Figure 1. Flow of intervention, measurement, and analysis stages

2.1 Structured Project-Based Learning Model

A structured Project-Based Learning model was implemented in selected Industrial Engineering courses at Al-Maarefa University. The model was designed to provide systematic opportunities for students to practice and demonstrate professional soft skills within an engineering context. Unlike unstructured project assignments, the adopted PBL model incorporated clearly defined phases, instructor supervision, and formal deliverables. The PBL model consisted of four sequential phases.

At the beginning of the course, students were introduced to the project objectives, scope, expected outcomes, and evaluation criteria. Project topics were either proposed by the instructor or selected by students subject to approval, ensuring alignment with course learning objectives. During this phase, project requirements, constraints, and expected deliverables were clearly communicated. Moreover, students developed a project plan outlining tasks, timelines, and individual responsibilities. For team-based projects, roles were distributed among team members to promote collaboration, accountability, and leadership. This phase emphasized planning, coordination, and time management skills, which are essential components of professional engineering practice. Also, during the execution phase, students worked on project tasks while receiving periodic feedback from the instructor. Progress checkpoints were used to monitor task completion, address challenges, and ensure adherence to project plans. These checkpoints also encouraged regular communication within teams and facilitated early identification of issues related to workload balance or coordination. Finally, at the end of the project, students submitted a written report and delivered an oral presentation. This phase focused on developing technical communication and presentation skills. Instructor feedback was provided on both technical content and communication effectiveness.

2.2 Questionnaire Design

To evaluate students' perceptions of soft-skill development associated with the structured Project-Based Learning (PBL) experience, a structured questionnaire was developed based on soft-skill dimensions commonly reported in engineering education literature. The instrument was designed to measure six predefined constructs: Teamwork Skills, Communication Skills, Time Management Skills, Leadership Skills, Problem-Solving Skills, and Presentation Skills. Each construct was measured using multiple items to capture different aspects of the corresponding skill domain. All closed-ended items were rated using a five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). In addition to the soft-skill constructs, three items were included to assess overall PBL perception, focusing on workload appropriateness, project structure, and perceived overall skill development.

The questionnaire content was informed by prior research on Project-Based Learning and professional skill development in engineering education, ensuring conceptual relevance and content validity. The instrument was reviewed for clarity and consistency prior to distribution. Table 1 presents the questionnaire constructs, item codes, and corresponding statements used in this study. Internal consistency of each construct was subsequently evaluated using reliability analysis, as reported in the Results section.

Table 1. Questionnaire Constructs and Item Descriptions

Construct	Item Code	Question Statement
Teamwork Skills	TW1	I contributed effectively to my team.
	TW2	My team communicated regularly and clearly.
	TW3	I learned how to collaborate with different personalities.
	TW4	I can manage conflicts in group work.
Communication Skills	COM1	I feel more confident presenting technical information.
	COM2	I improved my ability to write clear project reports.
	COM3	I can express ideas more effectively.
Time Management Skills	TM1	I managed my tasks within deadlines.
	TM2	I balanced project work with other courses.
	TM3	I planned my work more effectively.
Leadership Skills	LEAD1	I took initiative during the project.
	LEAD2	I helped guide the team to meet project objectives.
	LEAD3	I feel more confident taking leadership roles.
	PS1	The project improved my analytical thinking.

Problem-Solving Skills	PS2	I used engineering tools or methods to solve problems.
Presentation Skills	PRES1	I am more confident when delivering presentations.
	PRES2	Instructor feedback improved my presentation abilities.
Overall PBL Perception	OV1	The project workload was appropriate for the course.
	OV2	The structured project phases helped me stay organized.
	OV3	Overall, the project-based learning experience improved my soft skills.
Open Question	What was the most beneficial part of the project? and What suggestions do you have to improve future projects?	
Note: All closed-ended items were measured using a five-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree). Composite scores for each construct were computed by averaging the corresponding items. The open-ended question was analyzed qualitatively and was not included in statistical analyses.		

2.3 Data Collection

The questionnaire was administered electronically to Industrial Engineering students who had completed courses incorporating the structured PBL model. Participation was voluntary, and responses were collected anonymously to encourage honest feedback. The survey was distributed near the end of the semester to ensure that students had sufficient exposure to all phases of the project. Demographic information, including academic year, GPA range, and project type (individual or team-based), was collected to enable subgroup comparisons during analysis. No identifying information was recorded.

2.4 Data Analysis

Data analysis was conducted in several steps, following the sequence illustrated in Figure 1. First, descriptive statistics were computed at the factor level. Factor-level statistics were used for interpretation and comparison. Factor scores were calculated by averaging the items associated with each soft-skill construct. Second, reliability analysis was performed using Cronbach's alpha to assess the internal consistency of each soft-skill construct. Only constructs demonstrating acceptable reliability were used for subsequent inferential analyses. Third, one-sample t-tests were conducted at the factor level to examine whether mean soft-skill scores were significantly different from the neutral midpoint of the Likert scale. These tests were used to assess students' perceived effectiveness of the structured PBL approach rather than to infer causal improvement. Fourth, group comparison analyses were conducted at the factor level to examine differences across student subgroups, such as academic year and GPA range.

3. Research Results Analysis

3.1 Descriptive Statistics and Reliability Analysis

Table 2 presents the descriptive statistics and reliability coefficients for the soft-skill constructs and overall PBL perception. Mean scores for the soft-skill constructs ranged from 3.42 to 3.79 on a five-point Likert scale. Among the constructs, Time Management Skills reported the highest mean score ($M = 3.79$, $SD = 1.20$), followed by Teamwork Skills ($M = 3.73$, $SD = 1.09$) and Communication Skills ($M = 3.63$, $SD = 1.03$). Leadership Skills showed the lowest mean score among the soft-skill constructs ($M = 3.42$, $SD = 1.13$). The Overall PBL Perception construct reported a mean score of 3.58 ($SD = 1.15$), indicating generally positive student perceptions of the structured Project-Based Learning experience.

Reliability analysis indicated acceptable to high internal consistency across all constructs. Cronbach's alpha values ranged from 0.7996 to 0.9068, exceeding the commonly accepted threshold of 0.70. The highest reliability was observed for Time Management Skills ($\alpha = 0.9068$), while Communication Skills demonstrated the lowest, yet acceptable, reliability ($\alpha = 0.7996$). These results support the use of composite construct scores for subsequent inferential analyses.

Table 2. Descriptive Statistics and Reliability Results (Construct Level)

Construct	Item Codes	No. of Items	Mean	SD	Cronbach's α
Teamwork Skills	TW1–TW4	4	3.73	1.09	0.87
Communication Skills	COM1–COM3	3	3.63	1.03	0.80
Time Management Skills	TM1–TM3	3	3.79	1.20	0.91
Leadership Skills	LEAD1–LEAD3	3	3.42	1.13	0.88
Problem-Solving Skills	PS1–PS2	2	3.59	1.20	0.81
Presentation Skills	PRES1–PRES2	2	3.50	1.35	0.88
Overall PBL Perception	OV1–OV3	3	3.58	1.15	0.87

3.2 One-Sample t-Test Results

One-sample t-tests were conducted to examine whether the mean scores of the soft-skill constructs and overall PBL perception differed significantly from the neutral midpoint of the Likert scale (test value = 3). The results are summarized in Table 3.

The results indicated that Teamwork Skills ($t = 2.69$, $p = 0.017$), Communication Skills ($t = 2.42$, $p = 0.029$), and Time Management Skills ($t = 2.64$, $p = 0.018$) had mean scores that were significantly higher than the neutral midpoint. In contrast, the mean scores for Leadership Skills ($t = 1.48$, $p = 0.159$), Problem-Solving Skills ($t = 1.98$, $p = 0.067$), and Presentation Skills ($t = 1.48$, $p = 0.160$) did not differ significantly from the neutral midpoint. Similarly, the Overall PBL Perception construct showed no statistically significant difference from the neutral midpoint at the 0.05 significance level ($t = 2.03$, $p = 0.061$).

Table 3. One-Sample t-Test Results (Test Value = 3)

Construct	T-Value	P-Value
Teamwork Skills	2.69	0.017
Communication Skills	2.42	0.029
Time Management Skills	2.64	0.018
Leadership Skills	1.48	0.159
Problem-Solving Skills	1.98	0.067
Presentation Skills	1.48	0.16
Overall PBL Perception	2.03	0.061

3.3 Group Comparisons (Exploratory Analysis)

Exploratory group comparisons were conducted to examine differences in students' perceived soft-skill development and overall PBL perception across GPA level, academic level, and gender. Given the small sample size and the ordinal nature of Likert-based composite scores, the Mann–Whitney U test was used for all comparisons. GPA categories were collapsed into High GPA (3.5–4.0) and Lower GPA (< 3.5) groups, while academic level was grouped as first year and second year or higher. The results of the group comparisons are presented in Table 4.

With respect to GPA-based comparisons, a statistically significant difference was observed for Time Management Skills ($U = 52.0$, $p = 0.037$), indicating different distributions of time management scores between high- and lower-GPA students. No statistically significant GPA-related differences were found for Teamwork Skills, Communication Skills, Leadership Skills, Problem-Solving Skills, Presentation Skills, or Overall PBL Perception ($p > 0.05$).

Comparisons across academic level revealed no statistically significant differences for any of the measured constructs, including soft-skill dimensions and overall PBL perception ($p > 0.05$). Similarly, gender-based comparisons showed no statistically significant differences across all constructs ($p > 0.05$).

Overall, the group comparison results suggest limited differences in perceived soft-skill development across student subgroups, with the exception of Time Management Skills across GPA levels. Given the exploratory nature of these analyses and the limited sample size, the findings should be interpreted with caution.

Table 4. Group Comparisons Using Mann–Whitney U Test

Construct	GPA (U, p)	Academic Level (U, p)	Gender (U, p)
Teamwork Skills	U = 45.0, p = 0.203	U = 36.5, p = 0.447	U = 34.5, p = 0.662
Communication Skills	U = 44.5, p = 0.356	U = 34.0, p = 0.561	U = 34.5, p = 0.662
Time Management Skills	U = 52.0, p = 0.037	U = 35.0, p = 0.419	U = 27.5, p = 0.825
Leadership Skills	U = 46.0, p = 0.153	U = 28.0, p = 1.000	U = 33.5, p = 0.743
Problem-Solving Skills	U = 39.5, p = 0.455	U = 22.5, p = 0.605	U = 39.5, p = 0.321
Presentation Skills	U = 41.5, p = 0.338	U = 27.0, p = 1.000	U = 33.0, p = 0.783
Overall PBL Perception	U = 37.0, p = 0.633	U = 19.0, p = 0.360	U = 39.0, p = 0.352

4. Research Discussion

This study examined Industrial Engineering students' perceptions of soft-skill development within a structured Project-Based Learning (PBL) environment. Overall, students reported generally positive perceptions, particularly for time management, teamwork, and communication skills. These results align with the intended structure of the PBL model, which emphasized planning, coordination, and milestone-based project monitoring. In contrast, perceptions related to leadership, problem-solving, and presentation skills did not differ significantly from the neutral midpoint. This pattern suggests that not all soft-skill domains may be equally supported within the current PBL structure, particularly those requiring explicit role rotation, open-ended decision-making, or repeated formal presentation opportunities.

Exploratory group comparisons revealed a statistically significant difference in time management skills across GPA levels, with higher-GPA students reporting stronger perceptions in this domain. This difference may reflect pre-existing variation in self-regulation and study habits rather than effects attributable solely to the PBL approach. No statistically significant differences were observed across GPA groups for other soft-skill constructs, nor across academic level or gender. Taken together, the findings suggest that structured PBL environments may be particularly effective in supporting organizational and collaborative skills, while the development of leadership and higher-order problem-solving skills may require additional instructional support.

5. Research Conclusion

This study investigated students' perceptions of soft-skill development within a structured Project-Based Learning framework implemented in Industrial Engineering courses. The results indicate generally positive perceptions, particularly for time management, teamwork, and communication skills. Exploratory analysis identified a significant difference in time management perceptions across GPA levels, while no consistent differences were observed across academic level or gender. These findings highlight the potential of structured PBL to support key professional skills while underscoring the importance of intentional instructional design when targeting more complex competencies. The study provides empirical evidence to inform the continued refinement of PBL practices in Industrial Engineering education.

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