International Journal of Learning, Teaching and Educational Research
Vol. 24, No. 8, pp. 272-295, August 2025
https://doi.org/10.26803/ijlter.24.8.12
Received Jun 4, 2025; Revised Jul 20, 2025; Accepted Jul 31, 2025

Corporate Approach in Work-Integrated Learning for Students of Engineering Programs

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Abstract. The intensifying integration of engineering, science, and education, along with the growing requirements for graduates' professional competencies, underscores the need for innovative and systematically structured approaches to engineering education. One such approach is the corporate model, which involves coordinated actions of all educational stakeholders and the integration of students into real industrial environments. This study proposes an adapted model of work-integrated learning based on a corporate approach, implemented in the engineering programs of a university in Kazakhstan. Unlike many models described in the literature, the emphasis is placed not only on industrial practice but also on comprehensive resource and organizational coordination between universities and companies. The model incorporates principles of institutional partnership, joint program design and assessment, and is supported by empirical analysis of company attractiveness factors, interaction formats, and the evaluation of four workplace dimensions. The pilot implementation of the model demonstrated an improvement in students' skills ranging from 5.46% to 16.74%. A total of 91.67% of students positively assessed the organization of workplace learning, and 83.33% highlighted the overall attractiveness of the model. The effectiveness of the model was confirmed using t-tests and one-way analysis of variance (ANOVA). The findings suggest that this model can be recommended for implementation in engineering programs of universities in developing countries.

Keywords: bachelor's degree program; corporate approach; engineering education; work-integrated learning; project work

1. Introduction

In the context of ongoing technological advancement, digitalization, and the transformation of the labor market, the interconnection between engineering, science, and education is becoming increasingly pronounced (Gutiérrez-Martínez

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et al., 2021; Karstina, 2022; Pizzagalli et al., 2025; Reddy, 2024; Servant-Miklos et al.). This increasing complexity necessitates that universities adapt proactively and flexibly to societal, economic, and technological transformations by designing educational programs that are innovative, inclusive, and aligned with contemporary professional demands (Brink et al., 2024; Lavado-Anguera et al., 2024; Rozan et al., 2024). Key directions in this context include:

- the development and implementation of strategies and action plans aimed at supporting students' employability and career advancement (Beke & Tick, 2024; Gamage & Dehideniya, 2025; Gilbert et al., 2022; Khampirat, 2021; Van Eck et al., 2019);
- active engagement with key stakeholders—industry partners, employers, and research institutions (Baboolal & Singaram, 2023; Thiruchadai Pandeeswari et al., 2022);
- the development of infrastructure to support applied research, innovation, and technology-based entrepreneurship (García-García et al., 2024; Klein & Mafra Pereira, 2020; Nørgaard et al., 2023; Radko et al., 2023; Vilanova et al., 2022).
- increased industry orientation and practical relevance of educational programs.

One of the most promising approaches to achieving these goals is work-integrated learning (WIL), which encompasses dual education models (Wurdinger & Allison, 2017), industrial internships, project- and problem-based learning implemented in real workplace environments (Cranfield et al., 2021; Karstina, 2025). These models are built on the synergy of university and industry resources, public sector engagement, collaborative governance, and shared assessment mechanisms (Gupta & Gupta, 2021; Marrero-Rodríguez & Stendardi, 2023; Weng, 2024; Yan et al., 2024).

By adopting these approaches, universities are better equipped to meet labor market demands and address the growing need for skilled engineering professionals (Publications Office of the European Union, 2023; UNDP, JSC Workforce Development Centre (WDC), AERC, 2024). Within this framework, the corporate approach gains particular relevance, emphasizing deeper and more sustainable cooperation with industry. It includes not only the organization of internships but also the joint development of curricula, mentoring systems, technology transfer, and administrative and organizational partnerships (Gamage & Dehideniya, 2025; Niiranen, 2021; Pérez-Rodríguez et al., 2022; Qu et al., 2020; Rahman et al., 2023; Valero, 2022). Theoretically, the corporate approach draws upon three interrelated pillars:

- psychological and pedagogical foundations of collaboration and mentoring (Coleman, 2025);
- development of professional and transversal competencies in authentic work environments (Wardani et al., 2025);
- the use of digital technologies, resource management systems, and learner support mechanisms (Qiu et al., 2025).

These components form the basis of an integrative partnership model in which universities and companies co-design, implement, and evaluate educational processes with a focus on enhancing students' employability. At the same time, the corporate approach facilitates a structured transfer of current industry expertise, supports joint administrative and operational planning, and drives the alignment of academic curricula with the practical needs and emerging trends of the industrial sector (Gutiérrez-Martínez et al., 2021; Weng, 2024).

Recent studies by Namjildorj (2025) and Zhuang et al. (2025) underscore the importance of such models. The first emphasizes the limited integration of soft skills in university curricula, which hinders graduates' career adaptability. The second explores university–industry partnership strategies in Asian countries, where the industrial sector plays an active role in educational reform. Both studies highlight the need for flexible and resilient models that align academic objectives with labor market priorities, directly reflecting the aims of the present research.

These conclusions align with international models of Work-Integrated Learning (WIL), which reflect a wide range of strategies for bridging education and employment. The Work-Integrated Learning Curriculum Classification (WILCC) model (Dean et al., 2020) offers a typology of WIL activities based on their proximity to authentic practice and ensures institutional coherence in learning trajectories. Díaz et al. (2025) propose a tiered model grounded in the concept of communities of practice, encompassing various levels of student involvement—from peripheral participation to full integration. Pennaforte and Fannon (2025) discuss hybrid professionalization, proposing a model where companies co-develop curricula, offer structured mentoring, and evaluate learning outcomes, while instructors act as mediators between academia and industry.

However, despite notable theoretical progress in WIL, several critical issues remain unresolved, including:

- the lack of a transferable, systematically structured model of university–industry collaboration specifically designed for engineering education.
- limited empirical research addressing the factors that determine the attractiveness of companies as collaborative partners for universities and students.
- a lack of quantitative assessment of the effectiveness of WIL practices.
- limited consideration of institutional and resource-related barriers, particularly in the context of developing countries.
- restricted applicability of existing WIL models in the context of resource-constrained higher education systems.

This study seeks to bridge these gaps by proposing a customized corporate-oriented model of work-integrated learning, implemented within the engineering programs at a university in Kazakhstan. The model incorporates principles of institutional partnership, workplace integration, and collaborative outcome evaluation. It is complemented by an empirical analysis of company attractiveness factors, interaction barriers, and a comparative assessment of student progress in the experimental and control groups. These elements enable the model's adaptation to the conditions of engineering education in developing countries and expand the practical potential of the corporate approach in preparing engineering professionals.

The aim of this study is to develop and pilot a work-integrated learning model based on the corporate approach. To achieve this aim, the study sets the following objectives:

1. To define the key principles of the corporate approach within engineering degree programs.
2. To analyze the factors that influence the attractiveness of companies as partners for WIL and graduate employment.
3. To evaluate the development of professional skills in students participating in the corporate-based WIL model, compared with those in a control group.

2. Research Methods

This study employed a constructivist approach to explore the perceptions of employers, teachers, and students regarding the concept of work-integrated learning based on a corporate approach. In the context of this research, the corporate approach refers to a system of coordinated actions among all stakeholders in the educational process, designed to update curriculum content, develop students' professional skills, and support their career development.

The proposed model focuses on students' acquisition of the practical components of core engineering courses through engagement in real-world production environments, under the supervision of mentors and with access to both university and company resources. Key elements of the model include early professional involvement of students and structured feedback from both academic and industry sectors.

Empirical data were obtained through a large-scale survey involving 921 students, 143 academic staff from technical and multidisciplinary universities in Kazakhstan, and 108 representatives of engineering firms collaborating with universities within dual and practice-integrated education frameworks. The student sample comprised those in their 3rd or 4th year of bachelor's studies in engineering disciplines, as these stages typically involve specialized training and industrial placements. Faculty members included in the study had at least five years of teaching experience and were engaged in core subject instruction. Companies were selected based on their experience in collaborating with universities in areas such as professional internships, dual education, and mentoring.

The student sample demonstrated a high level of self-reflection. In response to closed-ended survey items (with options "Yes," "No," and "Not sure"), 98.6% of students confirmed that they regularly reflect on their skill development; 97.2% reported tracking their personal and professional growth; 90.2% indicated that they had learned through observing professionals; and 84.7% had experience in completing project-based assignments. These results highlight students' awareness of their educational trajectory and exposure to practical learning environments, supporting the reliability of their responses in evaluating key factors of work-integrated education, their satisfaction with the quality of practical training, and the main challenges encountered during company-based learning.

Among the company representatives, data on job roles were obtained through a closed-ended question. According to the responses, 10% held executive positions, 26.7% were department managers, and 56.7% were engineers or technical specialists. This distribution allowed the analysis to account for managerial, engineering, and administrative perspectives. The structure of respondents reflects a typical ratio in dual and work-integrated learning settings, where one instructor or mentor supervises an average of 6 to 10 students, depending on the program's specifics—an estimate supported by internal regulations of universities in Kazakhstan.

The survey was structured around five thematic blocks: 1) the forms and degree of company involvement in engineering student training, 2) factors determining the attractiveness of companies as educational environments, 3) quality of company resources and their availability for students, 4) developed skills of students in practice-integrated learning, 5) student satisfaction with the outcomes of work-integrated learning (see Appendix 1). A variety of question formats were used, including open-ended, closed-ended, and Likert-scale items. A five-point Likert scale was applied both to assess levels of agreement (5 – strongly agree to 1 – strongly disagree) and the perceived importance of parameters (5 – very important to 1 – not needed). The questionnaires were pilot tested with small groups to eliminate semantic and terminological ambiguities.

The reliability of the instrument was evaluated using Cronbach's alpha:

$$\alpha = \frac{N}{N-1}\left(1 - \frac{\sum_{i=1}^{N} D_{Y_i}}{D_X}\right),$$

where $X = \sum_{i=1}^{N} Y_i$, D_X is the dispersion of the total sum of scores of all questions of the questionnaire, D_{Y_i} is the dispersion of scores for each individual question of the questionnaire, N is the number of respondents for a particular target group. The resulting a-values ranged from 0.80 to 0.94 across all respondent categories, indicating high internal consistency.

To ensure the validity of the analysis, questionnaires with systematically incomplete or abnormal response patterns were excluded. The final dataset was processed using descriptive statistics. Each of the five thematic blocks contributed to building and justifying the structured model of work-integrated learning based on the corporate approach. The first block explored university–company collaboration and its integration potential. The second examined the attractiveness of companies as learning environments, covering physical, organizational, social, and economic characteristics of the workplace. The third block evaluated the quality and accessibility of resources provided by companies for training purposes. The fourth assessed the level of students' professional skills—measured before and after model implementation—to track learning dynamics. The fifth focused on student satisfaction with learning outcomes.

To assess the model's effectiveness, an experimental pilot was carried out. The experimental group included twelve fourth-year students from the "Radio Engineering, Electronics and Telecommunications" program who were trained using the corporate learning model. The control group comprised twelve students from the same program and year of study who followed the traditional curriculum. Group matching was based on academic level, year of study, and internship experience, helping minimize external influences and ensure valid comparisons. The small sample size reflects the limited number of programs in which the pilot implementation was carried out.

The pilot featured project-based learning in real-world professional settings with participation from partner companies, mentors, and university instructors. The core objective was to detect changes in the development of key competencies necessary for employability in engineering fields. Effectiveness was evaluated over one academic semester by tracking students' skill development progress in both groups. Progress was measured as the difference between post- and pre-module self-assessments collected after each micro-module involving engineering project tasks in real company settings. The study adhered to ethical research guidelines. All participants were informed in advance about the research goals and provided written consent. Data collection was anonymous, voluntary, and confidential. The study complied with the university's internal regulations for conducting pedagogical and applied research involving students.

To quantify changes in students' professional competencies, a paired-sample t-test was used. Mean values before and after the model implementation were compared within the experimental and control groups. Calculations were performed in Microsoft Excel using the T.TEST function (Type 1 – paired, two-tailed test). Statistical significance was set at $p < 0.05$. The analysis covered nine core skills: solving complex problems, applying non-standard solutions, using professional databases, systems-level understanding of the field, professional communication, operating engineering equipment, using ICT tools, critical thinking, and making decisions.

Additionally, a one-way analysis of variance (ANOVA) was applied to identify statistically significant differences between the experimental and control groups across each skill dimension. This method enabled the identification of variations in perceived and actual learning outcomes across formats. Results were evaluated using a five-point Likert scale, with a significance threshold set at $a = 0.05$.

ANOVA results were supplemented by comparisons of means and variances, and by paired t-tests to examine within-group learning dynamics, offering a comprehensive view of the model's impact. ANOVA was also used to compare perceptions of university–industry collaboration among students, instructors, and company representatives, allowing identification of differences in the perceived relevance and implementation of collaboration formats such as mentoring, curriculum co-development, and participation in thesis defenses. The collected quantitative and qualitative data provided a solid empirical foundation for the design, implementation, and evaluation of the work-integrated learning model based on the corporate approach.

3. Research Results

In a broad sense, practice-integrated learning based on the corporate approach can be conceptualized as an integrative model that facilitates cooperation among multiple stakeholders at key stages of workforce development: 1) forecasting labor market needs, 2) fostering the development of professional identity, 3) providing advanced and practice-oriented professional education, 4) assessing and certifying core and transferable competencies, and 5) training and professional development of teachers, mentors, and company employees.

The core actors in this model are government bodies, the industrial sector, and universities. A clear understanding of each stakeholder's role—along with a systematic analysis of their needs and strategic priorities—enhances the quality and relevance of educational programs in alignment with both academic standards and labor market demands.

Within this framework, it is particularly important to identify the preferred forms of partnership between universities and companies and to explore how their respective priorities can be operationalized within the work-integrated learning model.

3.1 Analysis of university–industry collaboration formats

The analysis of mean values and variability in respondents' assessments revealed that companies are most actively involved in activities aimed at students' career orientation and skills development, such as career guidance sessions, internships, and consultations. These formats contribute to enhancing students' learning motivation, developing career trajectories, and increasing awareness of labor market expectations. At the same time, company involvement in areas such as workforce forecasting, assessment of professional competencies, and joint use of resources with universities remains limited. Fewer than half of the company representatives reported participating in the design and management of educational programs, while approximately 70% expressed dissatisfaction with the quality of graduate preparation.

Results of the one-way analysis of variance (ANOVA) (see Table 1) revealed statistically significant differences ($p < 0.01$) in perceptions of collaboration formats among the three respondent groups. In all cases, the observed F-values exceeded the critical threshold ($F > F_{critical}$), indicating the significance of these differences. Faculty members ($F = 7.686$) primarily emphasized academic formats of cooperation. Company representatives ($F = 6.97$) favored practical-oriented formats such as mentoring and internships. Students ($F = 1.846$) exhibited the least pronounced differences, likely due to limited experience in industry interaction. These findings, presented in Table 1, highlight the need for more flexible and adaptive university–industry cooperation formats within the framework of work-integrated learning.

Table 1: Results of one-way ANOVA: differences in perceptions of university–industry collaboration formats by respondent group

Group of respondents	F	$F_{critical}$	p-value	Differences
Students	1.846	1.543	0.009	Moderate
Teachers	7.686	1.559	5.57×10^{-23}	Very pronounced
Company employees	6.97	1.56	4.36×10^{-20}	Pronounced

3.2 Factors contributing to the attractiveness of a company as a work-integrated learning environment

At the initial stage of model development, four key factors were identified as shaping a company's attractiveness for work-integrated learning (WIL) in engineering programs:

1) working conditions, including comfort, safety and functionality of the workplace,
2) employment prospects, including the availability of job vacancies,
3) social support and remuneration during workplace-based training,
4) student involvement in the production process.

These factors were assessed using a five-point Likert scale. According to students, the most important factors were employment prospects and working conditions (see Figure 1).

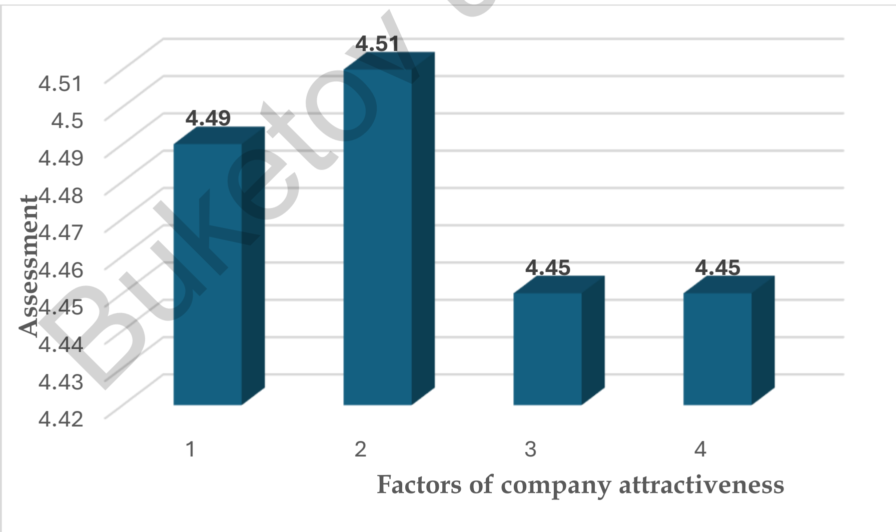

Figure 1: Student assessment of company attractiveness factors for work-integrated learning: 1) working conditions, 2) employment prospects, 3) social support and remuneration, 4) involvement in production process

The findings confirm that the ability of a company to offer a safe, comfortable, and functional workplace—combined with clear career prospects—significantly increases its attractiveness as a learning environment. Moreover, the evaluation of the workplace is shaped by four interrelated aspects: physical, organizational, social, and economic.

In the second phase of developing the model, these dimensions were systematically examined through survey data collected from students, faculty members, and company representatives. In this study, the physical aspect of the workplace was assessed through the availability of equipment, technological infrastructure, and information resources.

The organizational aspect was evaluated based on students' awareness of company rules and production requirements, training schedules, work assignments, contractual obligations among university, student, and company, and the extent of student involvement in workplace learning design. The social aspect included opportunities for professional communication, mentoring, social integration, and timely feedback on skill development. The economic aspect encompassed the workplace's adaptability to industry changes, alignment of qualifications with company demands, and student awareness of career trajectories.

The importance of all four aspects was acknowledged by 95% of students surveyed. Company staff prioritized the physical aspect (61.67% of respondents), while university faculty emphasized organizational and social dimensions. These findings suggest the need for a balanced, multi-stakeholder approach to evaluating workplace quality. Such a balance supports the holistic development of employability skills, broadens learning objectives, aligns educational programs with company expectations, and enhances student motivation and company appeal. Accordingly, the proposed corporate-based WIL model emphasizes equal importance of all four aspects of the workplace environment.

3.3 Priority professional skills

At the third stage of model development, a list of priority skills essential for the successful employment of engineering graduates was compiled. The assessment of skill relevance was based on survey data collected from three key stakeholder groups: students, faculty members, and company representatives. The final list included the following skills: 1) application of modern methods of data processing and interpretation, including computer-based techniques, 2) use of professional databases, 3) operation of modern engineering equipment and technologies, 4) critical analysis, evaluation, and synthesis of new and complex ideas, 5) solving complex problems, 6) professional communication, 7) identifying and applying non-standard solutions, 8) systems-level understanding of the field of study, 9) drawing conclusions and making decisions.

The survey results revealed a high degree of agreement among all three groups regarding the importance of these competencies. Company representatives emphasized skills related to the operation of engineering equipment and the solving of practical tasks, instructors prioritized critical thinking and systems analysis, while students highlighted professional communication and the ability to find non-standard solutions. This set of skills served as the foundation for the development of project assignments and the system for monitoring student progress.

3.4 Comparison of work-integrated learning strategies and assessment of skill development progress

At the fourth stage of model development, a corporate-based strategy for work-integrated learning (WIL) was designed. Based on the recommendations of partner companies, project-based learning was selected as the primary form of students' practical activity. The topics of the projects for the experimental group were defined by the partner company. The projects were implemented at company-provided workplaces, considering established requirements related to the physical, organizational, social, and economic aspects of the workplace. The project was divided into three micro-modules. In designing each micro-module, emphasis was placed on ensuring quality, transparency, and relevance.

This approach allowed for: 1) alignment of student tasks with the specifics of the educational program, the industry context, the partner company, and the intended learning outcomes, 2) measurability of project outcomes and acquired competencies, clear regulation of student workload, and transparency of project goals and objectives, 3) attainment of concrete results within each micro-module, evaluated by the student's ability to perform specific professional functions. Each micro-module included clear and transparent assessment criteria and tools.

In the first micro-module, students gained a general understanding of how the project outcomes could impact themselves, the company, and society, thus enhancing the relevance and motivation for completing the projects. In the second micro-module, students explored all theoretical aspects related to the project task, received consultations from industry professionals, conducted independent research on technologies used in similar projects, and analyzed the production system integrating various resources, processes, and interdisciplinary approaches. With the support of both university instructors and company mentors, students developed a comprehensive project strategy, conducted preliminary studies, reviewed technical documentation, and built an algorithm for solving the project task.

The third micro-module involved the implementation of the developed strategies and algorithms, during which students received regular feedback from instructors and industry experts. Each micro-module culminated in a measurable outcome assessed in terms of the student's ability to perform a specific professional function. This approach allowed for timely identification and resolution of skill gaps, broadening students' competencies and enhancing their value in the labor market. Throughout the project, a university instructor provided continuous monitoring and feedback to all participants involved in the WIL process.

For the control group, a similar project-based learning strategy was applied. However, students in the control group completed their projects in university laboratories and received guidance only from university instructors. Project topics and requirements for the control group were determined by the academic curriculum. A comparative analysis of the learning strategies used in the experimental and control groups is presented in Table 2.

Table 2: Comparative analysis of learning strategies in experimental and control groups

Feature	Control group	Experimental group
Project location and resources used	Students worked in university laboratories, receiving instructions and feedback from the instructor. They used university resources, theoretical knowledge obtained in class, and additional knowledge from available sources.	Students worked at company-provided workplaces, receiving feedback from instructors, mentors, and industry experts. They used resources from both the university and the company, academic knowledge, and information from company-provided sources.
Project topics and requirements	Defined by the academic curriculum	Defined by the company
Project assignment and methods of its implementation	Students carry out the project assignment in accordance with the theoretical component of the academic curriculum. The project is completed in a group consisting of students from the same academic year and the same degree program.	Students carry out a project assignment that goes beyond the theoretical component of the academic curriculum. The project is completed in a group that may include students from other academic programs as well as company experts.
Project results	A developed schematic or device, a presentation and a report on the work completed, along with recommendations for implementing the results in a specific company. The proposed solution must be optimal and correspond to the best among the considered alternatives.	
Project evaluation	An evaluation committee is formed, consisting of the responsible university instructor, a mentor, and a company expert. The assessment is conducted based on the student's readiness to perform a specific professional function.	

The pilot testing of the proposed model was conducted over one academic semester. The experimental and control groups worked in parallel. Students in the experimental group designed power supply schematics and circuits tailored to specific requirements, assembled wireless data transmission devices, developed IoT network architectures, created plans for satellite television distribution, assessed the readiness of broadcasting equipment, and formulated algorithms for testing communication and signal systems.

These tasks required additional expertise in electronic engineering, practical skills in assembling devices, and the use of specialized software. Students documented each project phase, described applied technologies and testing outcomes, explained malfunctions, and mapped processes. They had autonomy in choosing how to approach the project and were able to consult with mentors and industry experts.

Throughout the implementation of the corporate-based WIL model, students' skill development progress was assessed after each micro-module. Progress for each skill (*PS*) was calculated using the following formula:

$$PS = A_{final} - A_{initial},$$

where $A_{initial}$ is the baseline skill assessment and, A_{final} is the post-module assessment. The comparative analysis of student progress in both groups is presented in Table 3.

Table 3: Progress in skill development (PS) of students based on pilot implementation of the corporate-based work-integrated learning model

№	Assessed Skills	PS (experimental group)	PS (control group)
1	Application of modern methods for data processing and interpretation, including computer-based techniques	5.46%	1.84%
2	Use of professional databases	7.17%	0.1%
3	Operation of modern engineering equipment and technologies	8.44%	2.71%
4	Critical analysis, evaluation and synthesis of new and complex ideas	12.74%	8.24%
5	Solving complex problems	13.39%	7.03%
6	Professional communication	14.84%	13.12%
7	Identifying and applying non-standard solutions	14.02%	5.63%
8	Systems-level understanding of the field of study	16.14%	10.85%
9	Drawing conclusions and making decisions	16.74%	14.25%

According to the data presented in Table 3, it can be noted that the instructional strategies employed in both the experimental and control groups contributed to the improvement of all assessed student skills. However, the improvement was more substantial in the experimental group. For instance, students in the experimental group demonstrated greater development in skills related to critical analysis, evaluation, and synthesis of new and complex ideas, as well as in finding and applying non-standard solutions, including complex problems. This was facilitated by students' immersion in a real professional environment, combined with the autonomy to choose and implement strategies for solving project tasks, and the optimal selection and application of engineering and scientific tools during project implementation.

Skills such as professional communication, drawing conclusions, and decision-making were enhanced among students in the experimental group through professional interactions with industry experts, company mentors, university instructors, and project team members. At the same time, the progress in these skills was approximately the same in both groups, with a difference of no more than 2.5%.

The development and enhancement of skills in the use of modern engineering equipment and technologies, data processing and interpretation methods, and work with professional databases in the experimental group were supported by the practical application of theoretical knowledge acquired at the university, along with access to the company's engineering, informational, and technological resources. By implementing projects with access to company resources and equipment, students in the experimental group were able not only to deepen their appreciation of the practical value of their existing knowledge and competencies but also to refine and expand them within a real-world professional setting.

3.5 Between-group and within-group statistical analysis

To assess differences in the levels of professional skill development between the experimental and control groups after the model's implementation, an independent-samples t-test was performed alongside a one-way analysis of variance (ANOVA). Both methods were used to compare the mean values of key indicators of professional training, such as critical thinking, operation of engineering equipment, and solving complex problems. Although the experimental group demonstrated higher mean values across most indicators, no statistically significant differences between the groups were identified ($p > 0.05$).

This may be attributed to the limited sample size. Similarly, the ANOVA results did not reveal significant differences between the groups ($F < F_{critical}$), confirming the findings of the t-test. Nevertheless, the consistently positive trend observed in the experimental group suggests the potential of the proposed model, particularly in the context of scaling.

To provide a more in-depth assessment of the model's effectiveness, a paired t-test was conducted within each group to measure changes in skill development before and after the implementation phase. The results are presented in Table 4.

Table 4: Results of paired t-test: changes in students' professional skills before and after the implementation of the corporate training model

№	Evaluated Skill	p (Experimental group)	p (Control group)	Conclusion
1	Solving complex problems	0.236	0.977	No statistically significant changes in either group
2	Identifying and applying non-standard solutions	0.001	0.256	Statistically significant improvements only in the experimental group
3	Use of professional databases	0.538	0.991	No statistically significant changes
4	Systems-level understanding of the field of study	0.0016	0.020	Statistically significant improvement in both groups; stronger in the experimental group
5	Professional communication	0.00027	2.26×10^{-5}	Statistically significant improvement in both groups; comparable effect
6	Operation of modern engineering	0.023	0.826	Statistically significant improvements only in the experimental group

	equipment and technologies			
7	Application of modern methods for data processing and interpretation, including computer-based techniques	0.929	0.494	No statistically significant changes
8	Critical analysis, evaluation and synthesis of new and complex ideas	0.243	0.261	No statistically significant changes
9	Drawing conclusions and making decisions	0.068	0.140	Trend toward improvement in the experimental group (p ≈ 0.07)

The analysis revealed that the experimental group achieved statistically significant improvements in four skill areas: identifying and applying non-standard solutions, systems-level understanding of the field of study, professional communication, and operation of modern engineering equipment and technologies. There was also a clear trend toward improvement in drawing conclusions and making decisions (p = 0.068).

In contrast, the control group showed statistically significant progress in only two areas—systems-level understanding and professional communication—likely due to natural academic progression. These findings support the effectiveness of the corporate learning model in enhancing practical-oriented competencies among engineering students.

3.6 Stakeholder feedback on the corporate-based work-integrated learning model

The feedback results indicate a high level of acceptance of the model by both students and company representatives. Specifically, 91.67% of students in the experimental group gave a positive assessment of the corporate learning approach, and 83.33% highlighted the overall attractiveness of the model. The majority of respondents highlighted the critical importance of integrating company resources into the educational process and provided high evaluations of the organization of workplace-based training (91.67%).

The average rating of the accessibility of company resources was 4.15 out of 5, while their structure and quality received an average rating of 4.17. Company representatives rated students' readiness to use available resources and equipment at an average of 4.08.

Qualitative data also support these findings. Students noted in interviews:

> *"Working in the company helped me understand how to apply what we learn at university to real-world tasks."*

"What I found valuable was not only the practical experience but also the opportunity to receive feedback from mentors and engineers. It gave me a new perspective on my future profession."

"It was important that we could discuss the project not only with our instructor but also with company staff — this gave us a new angle on familiar problems."

These reflections point to the development of students' ability to transfer academic knowledge into practice.
Faculty members highlighted:

"Collaboration with companies helped us build a more practice-oriented approach to teaching. We now have a better understanding of what students truly need to learn."

"I see an increase in student motivation when they work on real projects in a real professional environment. It fundamentally changes their attitude toward learning."

Industry representatives also expressed positive views:

"We are interested in such forms of cooperation because they allow us to train future employees with the necessary skills and to immediately assess their potential."

"It is important that students begin to perceive work processes not as abstract theory, but as an integral part of their professional preparation."

Based on the feedback, evaluations, and comments from students and company staff, it can be concluded that the proposed corporate-based work-integrated learning model contributes to the development of employability-related skills and may be effectively implemented in engineering education programs. The feedback indicates that the pilot implementation of the model was successful.

4. Discussion

The findings of this study indicate that the successful implementation of a work-integrated learning (WIL) model based on a corporate approach requires comprehensive and systemic collaboration between universities and their industrial partners.

To enhance the effectiveness of engineering education, it is essential to: 1) employ effective mechanisms for assessing the strategic priorities of all stakeholders and integrating them into the educational process; 2) ensure active participation of companies, universities, and students in forecasting required competencies, planning instruction, and evaluating learning outcomes; 3) continuously monitor advancements in engineering and educational technologies and systematically integrate them into academic curricula; 4) evaluate the capacity of both university infrastructure and industrial partners' resources to support educational, research, and innovative activities; 5) take into account the key factors influencing a company's attractiveness as a learning and professional development environment; and 6) acknowledge the significance of physical, organizational, social, and economic conditions in shaping students' workplace experiences.

These conclusions align with previous research emphasizing the value of sustainable university–industry collaboration (Gamage & Dehideniya, 2025; Gutiérrez-Martínez et al., 2021; Pizzagalli et al., 2025).

The results demonstrate the effectiveness of the corporate approach in developing students' professional competencies. Students in the experimental group showed progress in skills ranging from 5.46% to 16.74%, compared to 0.1% to 14.25% in the control group. The most significant gains were observed in 1) critical analysis, evaluation, and synthesis of complex ideas; 2) solving complex problems; 3) professional communication; 4) the application of creative solutions; 5) systemic understanding of the field of study; and 6) drawing conclusions and decision-making.

These outcomes may be attributed to deeper immersion in the professional environment, greater autonomy in project strategies, and access to company resources, including engineering tools and technologies. Comparable improvements in communication and decision-making in both groups suggest the inherent value of project-based learning regardless of implementation context. Limited progress in the control group on skills such as data analysis, use of professional databases, and application of engineering technologies highlights the need for universities to modernize infrastructure and strengthen industry integration. Access to company resources and expert mentoring clearly contributed to higher outcomes for the experimental group.

To evaluate the effectiveness of the model, both t-tests and one-way ANOVA were used. Paired t-tests revealed significant progress in the experimental group across several competencies, while changes in the control group were less pronounced. These findings are consistent with international studies on the benefits of WIL (Dean et al., 2020; Pennaforte & Fannon, 2025; Wurdinger & Allison, 2017). However, independent t-tests showed that differences between the groups did not reach statistical significance ($p > 0.05$), likely due to the limited sample size and short duration of the pilot study. Similar patterns were noted by Díaz et al. (2025), Gamage and Dehideniya (2025), who emphasize the importance of sustained WIL integration for long-term impact.

One-way ANOVA revealed statistically significant differences in perceptions of university–industry collaboration among students, instructors, and company representatives. The largest discrepancies concerned mentoring, joint curriculum design, and participation in final assessments—consistent with Gupta and Gupta (2021), who observed mismatched expectations between academic and industrial sectors. ANOVA results for post-trial comparisons between control and experimental groups did not reach statistical significance; however, the direction of change and consistency of evaluations in the experimental group confirm a positive trend (Weng, 2024).

Thus, the use of t-tests and ANOVA enabled a multidimensional assessment of the model's impact, identifying positive tendencies in skill development. Despite statistical limitations, the results support the model's scalability and relevance for engineering programs in developing countries.

The proposed corporate-based work-integrated learning model strengthens the synergy between universities and industry, aligns academic outcomes more precisely with labor market requirements, broadens the scope of instructional strategies, and enhances students' motivation, professional competencies, and employability. These findings are consistent with prior research on the value of partnership-based learning in engineering education (Baboolal & Singaram, 2023; Brink et al., 2024; Lavado-Anguera et al., 2024; Rozan et al., 2024; Yan et al., 2024).

This study confirms that a corporate-oriented WIL model can be an effective tool for enhancing engineering competencies in contexts where WIL is still developing. Its successful implementation, however, requires not only methodological but also institutional support. Future research should include longitudinal designs, broader samples, other engineering disciplines, and deeper employer involvement in curriculum co-design.

While the findings align with prior WIL studies (Dean et al., 2020; Pennaforte & Fannon, 2025; Wurdinger & Allison, 2017), this model introduces several distinct features. Unlike many existing frameworks, it emphasizes not only workplace practice but also the organizational and resource integration of universities and companies. The model consolidates typical WIL elements—internships, mentoring, and project work—into a unified system based on corporate coordination.

From a theoretical perspective, the model does not claim to introduce a radically new concept. Instead, it advances the practical typology of WIL by embedding four dimensions of workplace quality—physical, organizational, social, and economic—into the design of student projects and by implementing a multi-tier feedback framework involving instructors, mentors, and industry experts. This operationalization of the corporate approach offers potential for replication across diverse institutional contexts.

Nevertheless, several limitations must be acknowledged. The pilot nature of the study, single-semester timeframe, and limited sample size reduce the generalizability of the results and the ability to assess the sustainability of change. Some skills—such as ICT use and critical thinking—did not show statistically significant improvement, possibly due to insufficient integration in the project content. The model's effectiveness may also vary depending on industry characteristics, university autonomy, and the maturity of partnerships.

As Weng (2024) notes, the sustainability and replicability of WIL models depend on institutional readiness and faculty capacity to act as facilitators. In Kazakhstan, where such partnerships are emerging, the proposed model can serve as a step toward institutionalizing dual education. To scale the model effectively, we recommend: 1) institutionalizing company participation in program design and evaluation; 2) formalizing mentoring and joint project management mechanisms;

3) developing digital infrastructure to track student progress; and 4) considering cultural and regional factors in implementation.

5. Funding

This research is funded by the Committee of Science of the Ministry of Science and Higher Education of the Republic of Kazakhstan (Grant No. AP19679248 - "Integration of new forms of corporate training in the implementation of dual education programs in engineering and science").

6. Conclusion

This study presents a corporate-based model of work-integrated learning (WIL) aimed at enhancing the alignment of engineering education with the dynamic requirements of modern industry. The development of the model involved the identification of key factors contributing to the attractiveness of companies as learning environments, the assessment of four dimensions of the student workplace (physical, organizational, social, and economic), the formulation of a competency framework for employability, and the design of a project-based learning strategy supported by corporate partners.

The survey findings indicate that a company's attractiveness to students is substantially enhanced by its capacity to provide a safe, well-functioning, and supportive work environment, coupled with clear career prospects. Ensuring a balanced perception of workplace quality among all stakeholders contributes to a more coherent and demand-driven educational process. The pilot implementation of the model over one semester demonstrated a higher progression in professional skills among students in the experimental group (ranging from 5.46% to 16.74%) compared to the control group.

The most substantial improvements were observed in critical thinking, complex problem solving, systems thinking, and professional communication. These outcomes can be attributed to students' immersion in real professional environments, autonomy in project execution, and access to industrial equipment and expert mentoring. Furthermore, the model was well-received by students, who reported high levels of satisfaction, underscoring its perceived effectiveness in enhancing career readiness and self-confidence. Company mentors also acknowledged students' effective use of workplace resources and technologies.

Given the promising results, the proposed corporate-based WIL model is recommended for implementation in engineering programs, particularly within universities in developing economies. Its flexible, industry-responsive structure offers potential for scaling and adaptation, contributing to the enhancement of workforce-oriented education in rapidly evolving labor markets.

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Appendix 1

Survey questions

General Information:
Questions for students:
1. Name of the university and academic program.
2. Year of study (3rd or 4th).
3. Self-assessment of personal skills (communication, leadership, creativity, self-organization, stress resilience, emotional intelligence).

Questions for faculty and company representatives:
1. Name of the university/company and position.
2. Length of professional experience.
3. Experience in work-integrated student training (mentorship, internships, workplace-based training, etc.).

Block 1. The forms and degree of company involvement in engineering student training:
1. What forms of collaboration between the university and the company are currently in place?
2. How frequent is the interaction between the university and the company?
3. Which workplace-based learning methods do you consider most effective?
4. How are responsibilities and roles distributed between the university, mentors, and students during workplace training?
5. What measures, in your opinion, can enhance the quality of practice-oriented courses?

Block 2. Factors determining the attractiveness of companies as educational environments:
1. What key criteria should be considered when selecting companies for internships or workplace-based training?

2. How do you evaluate the organization of a student's workplace (comfort, equipment, safety)?
3. What measures ensure student safety and comfort at the workplace?
4. What employment and career advancement opportunities does the company offer to students after training?
5. How would you assess the company's involvement in the student learning process?
6. What challenges do students most frequently face during workplace-based training?
7. What types of social and informational support for students do you consider necessary?

Block 3. Quality of company resources and their availability for students:
1. How accessible are company and university resources to students?
2. What primary sources of information about these resources do you use (websites, mentors, social media, etc.)?
3. How frequently are company/university resources applied in the learning process?
4. How do you assess the relevance and informational value of these resources?
5. How user-friendly are the provided resources (interfaces, structure, accessibility)?
6. How would you evaluate the organization, functionality, and overall quality of company and university resources?

Block 4. Developed skills of students in practice-integrated learning:
1. Which professional competencies should be prioritized for student development?
2. What learning outcomes do you consider most significant?
3. What role do project-based and situational tasks play in developing professional skills?
4. How actively are students engaged in completing such tasks?
5. What difficulties do students face while working on projects or assignments?
6. What factors most contribute to the successful development of students' professional skills?
7. How would you evaluate your strengths and weaknesses (for students – in the professional context)?
8. What is the role of professional communication (with mentors, engineers, colleagues) in the learning process?

Block 5. Student satisfaction with the outcomes of work-integrated learning:
1. Are you satisfied with the outcomes of practice-integrated learning?
2. How valuable are the acquired knowledge and skills for your future professional growth?
3. How do you assess the practical relevance of the course and its alignment with professional requirements?
4. How would you evaluate the organization of training (logistics, interaction with mentors, support)?
5. How would you rate the quality of mentor performance?

6. Do you believe that the competencies and skills developed during the training are sufficient for employment in your field?
7. What career advancement opportunities become available after completing the training?
8. Does the training program meet the expectations of both companies and students?