BRIDGING DISCIPLINES: COOPERATIVE EDUCATION OUTCOMES IN INDUSTRIAL DESIGN AND MECHANICAL ENGINEERING

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ABSTRACT
This paper examines outcomes of a structured cooperative education model embedded in an undergraduate curriculum in which students alternate between campus-based study and workplace placements. Focusing on industrial design and mechanical engineering students participating in the same institutional model, the study investigates four dimensions: collaboration self-efficacy, reflective learning (including transfer), professional readiness/employability, and workplace integration quality (mentoring, feedback, task ownership, interdisciplinary exposure). A cross-sectional survey (N=85) was administered to students who had completed multiple placements; composite scales showed good to excellent internal consistency (Cronbach's α=.85–.95). To add explanatory depth, semi-structured interviews were conducted with 28 students (14 per department). Survey results indicate moderately positive perceived outcomes across all four dimensions, with no statistically significant differences by gender or department (all p>.05). Interview findings highlight that learning is amplified when placements provide responsibility, access to communication channels, and timely feedback, and that boundary crossing often depends on translating work through concrete artefacts (e.g., documentation, explanatory presentations) that make intent and constraints legible across roles.

Keywords: Cooperative education, work-integrated learning (WIL), interdisciplinary learning, industrial design education, engineering education, reflective learning, employability

1 INTRODUCTION
University-business collaboration-based applied education models aim to develop students' professional knowledge and skills not only in the classroom/studio environment but also within real work processes. Cooperative education and work-integrated learning (WIL) are widely used in design and engineering programmes to strengthen students' transition into professional practice through repeated workplace exposure. However, outcomes are not guaranteed by placement alone; learning depends on how students are integrated into workplace activity systems and how academic programmes scaffold reflection and transfer.

The paper discusses the results of co-operative education within an institutional model where all students undertake multiple work placements with external organisations. This study compares industrial design and mechanical engineering students along four perceived outcome dimensions: collaboration self-efficacy, reflective learning (including transfer), professional readiness/employability, and workplace integration quality. The survey results are further explained through interviews that provide insights into how students experience boundary crossing and professional identity development in practice.

'Cooperative education' in this paper is used to describe a structured cooperation between the university and host organisations that is based on repeated workplace placements embedded in the curriculum. The study does not assume that design and engineering students are always co-located in the same placement teams and compares students from the two departments within the same model.

While cooperative education is commonly framed as a 'bridge' between education and employment, evidence suggests that benefits depend on the conditions of participation—what students are allowed to do, who supports them, and how workplace experiences are connected back to academic learning.

Accordingly, this paper asks: (i) how do students in two adjacent disciplines perceive cooperative education outcomes across collaboration, reflection/transfer, professional readiness, and integration

quality; and (ii) what qualitative mechanisms help explain variation in experiences within the same model?

2 BACKGROUNDS

Work-integrated learning (WIL) conceptualises placements as curriculum components that are intentionally designed to link academic learning and workplace practice through supervision, assessment and support. The learning outcomes are influenced by the quality of mentoring, feedback, authentic participation and inclusive opportunities for meaningful task ownership.

Interdisciplinary learning can be conceptualised as boundary crossing, where learning occurs as participants negotiate differences in language, norms, and criteria across communities and practices. In design–engineering contexts, coordination is often mediated by artefacts such as sketches, prototypes, documentation, and presentations that render work legible across disciplinary perspectives.

Reflective practice is the process by which experience becomes learning through feedback and reflection on action and supports transfer between contexts. Professional identity formation entails continuing identity work on the basis of participation and recognition in professional communities. Placements can help refine preferred trajectories and hybrid roles (e.g., coordination-oriented identities).

Boundary crossing provides a useful lens for interdisciplinary learning because it foregrounds practical frictions—terminology gaps, mismatched quality criteria, and role ambiguity—and the coordination work required to resolve them. In design–engineering settings, artefacts such as sketches, CAD drawings, prototypes, documentation, and presentations can function as boundary objects that support alignment by externalising intent and constraints [1,5].

Across placements, identity work is often revealed through preference clarification ('what I want to do' vs 'what I do not want'), and for some students, a transition to hybrid roles such as coordination and planning. Usually, these identity signals are created through recognition and legitimacy in the workplace community and through the degree of authentic participation afforded to the interns [4,6].

3 METHOD

Design: A convergent mixed-methods design combined a cross-sectional survey with semi-structured interviews and brief written reflections to capture both outcome patterns and contextual explanations of students' cooperative education experiences.

Context: The model of cooperative education examined in this study can be viewed as a work-integrated learning (WIL) implementation that institutionalises repeated engagement in the workplace within the undergraduate curriculum. This setup allows to compare perceived outcomes for two disciplines located side by side in the same model.

Sample: Survey participants were undergraduate students from industrial design and mechanical engineering (N = 85; Industrial Design n = 43; Mechanical Engineering n = 39; missing department n = 3). Interviews were conducted with 28 students (14 per department).

Quantitative instrument: The survey instrument comprised four dimensions: (1) collaboration self-efficacy, (2) reflective learning and learning transfer, (3) professional readiness/employability, and (4) workplace integration quality (mentor support, feedback, task ownership, interdisciplinary exposure). Items used a 5-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree). Example items included "I was able to work effectively with people from different disciplines" and "I used feedback to improve how I work."

Qualitative reflections: Interviews (≈20 minutes) elicited critical incidents of cross-disciplinary collaboration, reflection triggers, identity insights, breakdowns in collaboration, and programme-level improvement suggestions. To retain focus while producing analysable accounts, participants were also asked to provide brief incident-focused reflections during or immediately after the interview.

Data analysis: Quantitative analyses included descriptive statistics and internal consistency (Cronbach's α). Group comparisons by gender and department were examined using independent-samples t-tests. Qualitative data were analysed using a structured thematic approach aligned to four analytic categories (boundary crossing, reflective learning/transfer, identity work, integration conditions), and representative quotations were selected for reporting in a space-constrained conference format (Table 2).

Ethical considerations: Participation was voluntary and based on informed consent. Interviews were conducted in Turkish; quotations were translated into English for reporting. Identifying details

(people/organisations) were removed and participants are referenced by anonymised codes (e.g., ID07, ME12).

4 RESULTS

The composite scales showed good to excellent internal consistency (Cronbach's α = .85–.95). Overall composite scores were moderately positive across all four dimensions (Table 1).

Independent-samples t-tests indicated no statistically significant differences in factor scores by gender or department (all $p > .05$).

The qualitative interviews show that the perceived outcomes are mainly affected by the affordances and boundary conditions of the workplace. Students reported learning gains when placements offered clear task ownership and timely feedback and students had access to appropriate communication channels, but limited responsibility or restricted access constrained participation and reduced confidence.

In both departments, boundary crossing often involved translating work into concrete artefacts (e.g. explanatory presentations, drawings, documentation) to align expectations and reduce terminology gaps. Identity work regularly took the form of making clear "what I want to do" vs. "what I do not want," and in some cases a shift toward hybrid coordination roles (e.g., project planning and cross-functional alignment).

For example, one participant contrasted placements by noting: "In one placement I was not given responsibility; in another I could participate directly in lab work." (ME07).

Another described boundary crossing as making work legible: "I prioritised being understood and prepared explanatory presentations." (ID07).

Table 1. Scale reliability and descriptive statistics for composite survey scores

Scale	Items (k)	Cronbach's α	N	Mean	SD
Collaboration self-efficacy	7	0.854	82	3.830	0.807
Reflective learning + transfer	7	0.887	82	3.873	0.832
Professional readiness / employability	11	0.940	82	3.987	0.835
Workplace integration quality	10	0.950	82	3.959	0.989

Table 2. Summary of interview themes and illustrative quotations (anonymised)

Scale	Items (k)	Cronbach's α	N	Mean	SD
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Qualitative theme	What it shows	Illustrative quote (anonymised)
Integration quality & agency	Responsibility, access, and mentoring enable learning; lack of responsibility constrains participation.	"In one placement I was not given responsibility; in another I could participate directly in lab work." (ME07)
Artefact-mediated boundary crossing	Students 'translate' across disciplines via presentations, drawings, and documentation.	"I prioritised being understood and prepared explanatory presentations." (ID07)

Legitimacy and role recognition	Intern status/title can shape whether collaboration is possible.	"Interns have no title… I first had to prove what I could contribute." (ME12)
Hybrid identity through coordination	Some students shift toward coordination and planning roles as meaningful professional practice.	"My work shifted toward project coordination—building schedules and plans." (ID09)

5 DISCUSSIONS

Survey findings suggest broadly similar perceived outcomes across gender and departmental groups, with interviews helping explain how variation is often driven by placement conditions rather than disciplinary labels alone. That is, the same institutional model can produce different learning experiences depending on the extent to which students are allowed authentic participation.

Workplace integration quality (mentoring, feedback, access to communication channels, and meaningful task ownership) emerged across cases as a practical lever for strengthening reflective learning and transfer. Students who were given responsibility and access and treated as legitimate contributors reported greater confidence, clearer transfer of learning, and greater willingness to collaborate cross-functionally.

Boundary crossing was often achieved by artefacts that made design intent or engineering constraints explicit (e.g. explanatory presentations, drawings, documentation). These artefacts supported shared understanding by reducing gaps in terminology and by externalising decisions in forms that could be evaluated and negotiated by other roles (technicians, engineers, managers).

From an education design perspective, these findings speak to low-cost programme levers: (i) setting minimum expectations for host organisations (role clarity, assigned mentor, feedback cadence, and at least one deliverable with ownership); (ii) embedding lightweight reflection prompts and debriefs to link workplace episodes back to coursework; and (iii) aligning assessment criteria so that workplace learning (tools, documentation, coordination practices) is recognised rather than considered peripheral..

Finally, qualitative accounts illustrate that professional identity development is often expressed as preference clarification ("what I want to do" vs "what I do not want") and, for some students, a shift toward hybrid coordination-oriented roles (e.g., planning, alignment work). For design and engineering educators, this suggests that cooperative education can be used deliberately to support identity work and interdisciplinary readiness, not only technical skill acquisition.

Limitations include reliance on self-reported perceptions and a single institutional model. Future work could model placement characteristics (e.g., sector, repeat placements, team composition) as predictors of outcomes and investigate longer-term trajectories after graduation.

6 CONCLUSION & IMPLICATIONS FOR DESIGN/ENGINEERING EDUCATION

Cooperative education can provide a common developmental framework across design and engineering students, but placements that offer authentic participation, feedback and clear structures for integration enhance learning.

Implications for programme design include: (i) strengthening mentor and feedback structures; (ii) embedding short guided reflections and debriefs to support learning transfer; (iii) designing opportunities for cross-functional interaction; and (iv) aligning assessment criteria so that workplace learning (including tools, documentation, and coordination practices) can be recognised and transferred into studio/engineering coursework.

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