Women in Engineering Commissioning Roles: A Neglected Frontier for Learning and Inclusion

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Abstract

Purpose: This conceptual paper introduces a framework explaining how commissioning culture influences women's workplace learning in engineering. Despite its intensity as a learning environment, commissioning—the phase where engineered systems are tested and brought online—remains largely unexamined in workplace learning scholarship, and women's participation in these settings is particularly under-researched.

Design/methodology/approach: Drawing on workplace learning theory, situated learning, and gendered organisational research, the paper synthesises existing scholarship to position credibility negotiation as the central mechanism linking commissioning culture to learning outcomes. The framework incorporates psychosocial pressures and organisational supports as key moderators.

Findings: The framework reveals how gendered norms shape women's access to experiential learning, tacit knowledge, and the formation of professional identity in high-pressure commissioning environments. Credibility negotiation emerges as the critical process determining whether women gain central or peripheral participation, with significant implications for capability development and inclusion.

Practical implications: The paper provides actionable strategies for engineering organisations to redesign commissioning as inclusive learning environments, including mentoring structures, team composition approaches, and leadership development

interventions. These recommendations support both gender equity and organisational capability development.

Originality/value: This is the first paper to theorise commissioning as a workplace learning environment and to examine how gendered dynamics shape learning opportunities in this critical but overlooked phase of engineering work. The framework provides new directions for workplace learning scholarship and establishes foundations for empirical investigation.

Keywords: Workplace Learning; Commissioning; Gender Equity; Women in Engineering; Situated Learning; Credibility; Professional Identity

1. Introduction

Workplace learning research has long emphasised that expertise develops through participation in authentic work activities, guided by access to social, material, and relational resources (Billett, 2001; Eraut, 2004). Commissioning—where engineered systems are tested, integrated, and brought online—represents one of the richest environments for such learning. Knowledge is predominantly tacit, the pace is rapid, and engineers must coordinate across organisational boundaries under intense scrutiny and temporal pressure. Yet commissioning remains invisible in workplace learning scholarship, and women's experiences within these environments are almost absent from research.

Commissioning typically occurs as the final phase of major engineering projects, spanning weeks to months depending on system complexity. Teams are temporary, cross-functional, and often include personnel from design firms, contractors, equipment vendors, and client organisations. Engineers must validate that systems perform as specified while troubleshooting integration issues in real time. This creates an intensive learning environment: decisions carry high financial and safety stakes, problems require rapid collaborative diagnosis, and success depends on interpreting system behaviour through both technical knowledge and experiential judgment. For early- and mid-career engineers, commissioning offers unparalleled opportunities to develop practical expertise—but only if they gain access to the problem-solving processes and tacit knowledge exchanges that characterise this work.

Women continue to be underrepresented in engineering (Engineers Australia, 2024; WGEA & BCEC, 2025), and even more so in site-based commissioning roles. Gendered workplace cultures, informal gatekeeping, and narrow norms of credibility restrict women's access to

high-value experiential learning (Faulkner, 2009; Hatmaker, 2013). While studies of engineering identity and learning have focused on education, early career experiences, and professional socialisation (Tonso, 2007; Cech & Blair-Loy, 2019), commissioning—where credibility, identity, and learning opportunities converge—is rarely examined.

This conceptual paper argues that commissioning is a neglected but critical frontier for workplace learning research. It introduces a framework explaining how commissioning culture shapes women's learning trajectories, focusing on credibility negotiation as the central mechanism linking culture to identity development and learning outcomes. The framework is designed to guide empirical investigation and inform organisational practice, with particular attention to actionable strategies for improving inclusion and learning in commissioning environments.

2. Commissioning as a Workplace Learning Environment

Workplace learning theory highlights that learning is situated, relational, and shaped by opportunities to participate meaningfully in practice (Billett, 2001; Fuller & Unwin, 2004). Commissioning exemplifies these conditions: engineers learn through collaborative troubleshooting, iterative decision-making, hands-on problem solving, and real-time interpretation of system behaviour.

2.1 Situated learning and communities of practice

Commissioning environments can be understood as communities of practice (Lave & Wenger, 1991), in which legitimacy and recognition determine access to central tasks. Women frequently enter commissioning teams as newcomers or minorities, making their movement from peripheral to central participation more contested. Gatekeeping, assumptions about expertise, and narrow norms of "who looks like an engineer" can restrict their access to the tacit, high-stakes learning commissioning offers.

While empirical research specifically examining commissioning environments is limited, the following theoretically derived scenario illustrates how the framework's mechanisms might operate in practice. This scenario synthesises patterns documented in research on gendered workplace dynamics (Faulkner, 2009; Hatmaker, 2013; Dabić et al., 2024) and situated learning in technical environments (Billett, 2001; Lave & Wenger, 1991).

“Consider a scenario where a water treatment plant commissioning team encounters unexpected pressure fluctuations during system testing. Senior engineers gather around the control panel, rapidly exchanging interpretations of sensor data and proposing diagnostic tests. A mid-career female engineer with five years' experience approaches—she has successfully commissioned similar systems previously. Despite her relevant experience, the discussion continues without pause for her input. When she offers a diagnostic suggestion based on a comparable issue she resolved six months prior, the team lead responds with scepticism: "Are you sure? The circumstances were probably different." A male engineer with similar experience arriving moments later is immediately drawn into the discussion: "Good timing, we could use another set of eyes on this." While both have equivalent qualifications, the differential reception shapes their opportunities to demonstrate expertise and engage in the high-stakes problem-solving that builds commissioning capability. She is later assigned to documentation duties, while the male colleague joins the diagnostic testing. Over time, this pattern of differential credibility assessment limits her development of the tacit knowledge and practical judgment that define commissioning expertise”.

2.2 Informal and experiential learning

Commissioning compresses learning processes. Engineers rely on informal exchanges, tacit cues, and rapid interpretation of complex information (Eraut, 2004; Billett, 2014). Successful participation requires trust, credibility, and access to senior engineers—yet these relational resources are unevenly distributed. When women's competence is questioned or overlooked, their access to learning becomes constrained, reinforcing inequities in capability development. This dynamic is particularly consequential in high-pressure technical environments where informal knowledge networks determine who learns what and learning opportunities are neither formally structured nor equally distributed (Trevelyan, 2014).

3. Credibility Negotiation as the Missing Link

Professional identity in engineering is tightly coupled to perceptions of competence, authority, and trustworthiness (Hatmaker, 2013; Faulkner, 2009). In commissioning, credibility must be demonstrated repeatedly in real time.

For women, credibility negotiation is intensified: scrutiny is heightened; errors carry greater social cost; contributions are more easily discounted; opportunities to "step up" are rationed (Dabić et al., 2024).

This process shape's identity formation and determines the extent to which women gain access to rich learning opportunities. When credibility is granted, women can move toward central participation, gaining tacit knowledge and experiential competence. When credibility is withheld, learning becomes restricted, peripheral, and slow. Credibility negotiation, therefore, functions as the mechanism through which culture influences learning outcomes.

The following scenario further illustrates how credibility withholding can restrict learning opportunities, drawing on patterns identified in research on gendered professional identity negotiation (Hatmaker, 2013; Faulkner, 2009) and workplace learning access (Billett, 2001).

"A mid-career female engineer with strong technical credentials joins a commissioning team to start up an industrial control system. Despite her expertise, she finds her suggestions questioned more frequently than those of male colleagues with similar experience. When she proposes a diagnostic approach that later proves correct, credit is attributed to the team collectively rather than to her individually. Over subsequent commissioning phases, she notices she is assigned tasks requiring meticulous documentation rather than system-level troubleshooting. This pattern of credibility withholding gradually restricts her access to the most developmentally valuable learning opportunities, even as her formal qualifications suggest she should be positioned centrally in the team's knowledge work".

4. Psychosocial and Organisational Moderators

4.1 Psychosocial pressures

Experiences of persistent credibility questioning and social marginalisation in commissioning environments can generate psychological strain that compounds learning barriers. While often labelled "impostor syndrome" (Clance & Imes, 1978), contemporary scholarship recognises these responses as rational adaptations to structurally inequitable environments rather than individual pathology (Bravata et al., 2020; Cokley et al., 2015). In commissioning's high-stakes, male-dominated culture, women may experience heightened self-doubt and reduced willingness to take on central tasks—not because of individual deficiency, but because gendered workplace structures consistently signal their contributions are less valued. These psychosocial consequences of structural barriers can inhibit

participation and limit identity development, creating a feedback loop that reinforces peripheral positioning.

4.2 Organisational supports

Mentoring, inclusive leadership, and flexible organisational structures can counteract exclusionary norms (Shore et al., 2011; Nishii, 2013). Supportive supervisors, collaborative team climates, and explicit recognition of commissioning as a learning environment expand access to tacit knowledge and reduce the effects of psychosocial strain. Organisations that treat commissioning as a developmental phase, rather than merely a technical milestone, create more equitable learning conditions.

“An engineering organisation redesigns its commissioning approach to include pre-deployment preparation sessions where team composition and learning objectives are explicitly discussed. A senior female engineer is assigned as co-lead with responsibility for mentoring junior engineers of all genders. The commissioning manager establishes norms for inclusive decision-making, regularly checks in with team members about their learning opportunities, and actively creates space for diverse contributions during troubleshooting sessions. In this environment, junior female engineers report feeling more confident asking questions, proposing solutions, and taking on challenging diagnostic tasks. The organisation's intentional framing of commissioning as a learning environment—not just a technical deliverable—enables more equitable access to developmental opportunities”.

These illustrative scenarios demonstrate how the conceptual framework's mechanisms—peripheral positioning, credibility negotiation, and differential access to learning—might manifest in commissioning practice. While grounded in established research on gendered workplace dynamics and situated learning, empirical investigation specific to commissioning environments is needed to document the prevalence, particular forms, and contextual variations of these dynamics across different engineering disciplines and project types.

5. Conceptual Framework

The framework synthesises workplace learning, gender, and identity theories to explain women's participation in commissioning:

- Commissioning culture shapes norms, expectations, and gatekeeping practices

- Credibility negotiation filters access to central involvement and tacit knowledge
- Identity formation emerges through recognition and meaningful involvement
- Workplace learning outcomes depend on these interconnected processes
- Psychosocial pressures and organisational supports amplify or reduce barriers
- A feedback loop exists: as women gain expertise and legitimacy, they can reshape commissioning culture and learning climates over time

This model positions commissioning as a dynamic, relational learning system—not only a technical stage of engineering work. These relationships are brought together in a conceptual model summarising how commissioning culture shapes women's learning pathways (Figure 1).

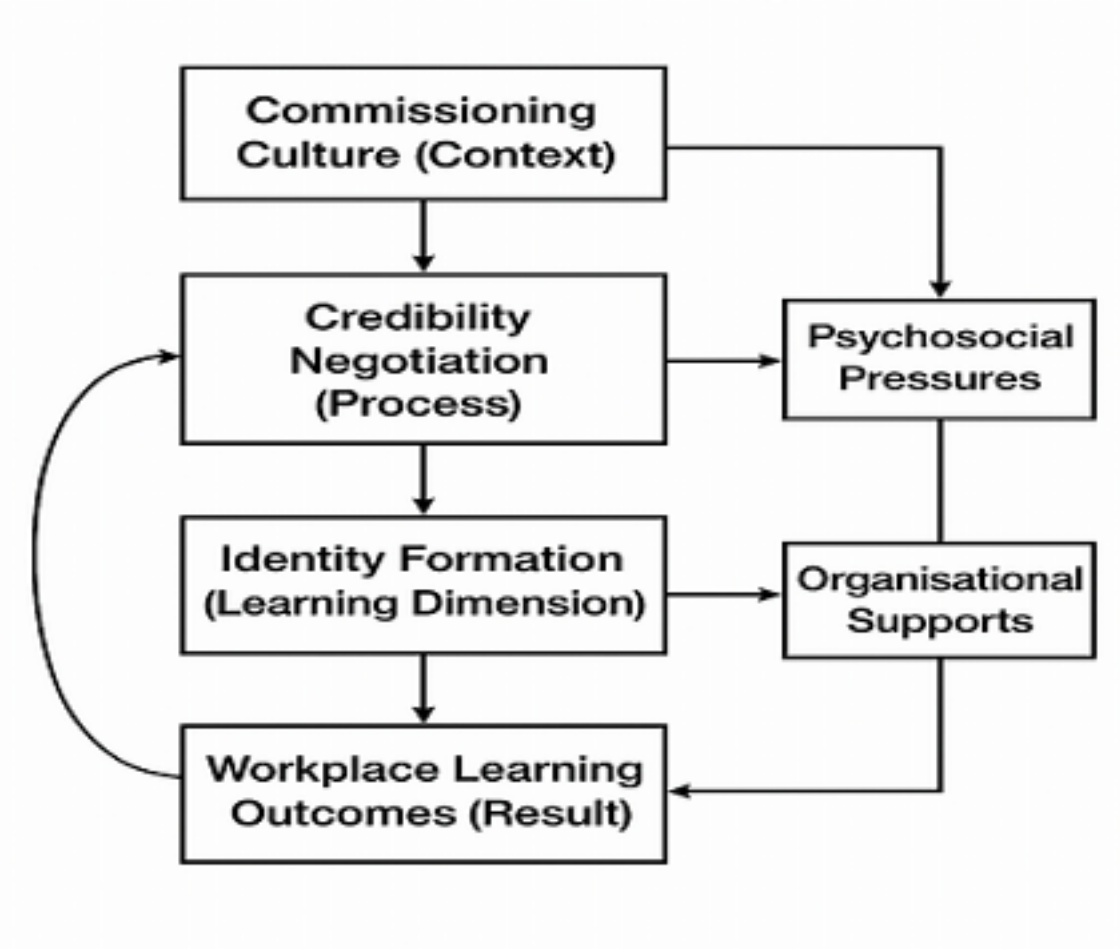

Figure 1. *Conceptual framework of women's learning pathways in commissioning. Commissioning culture shapes credibility negotiation, identity formation, and workplace*

learning outcomes, moderated by psychosocial pressures and organisational supports. A feedback loop illustrates how outcomes reshape culture.

As shown in Figure 1, the model positions credibility negotiation as the central mechanism linking commissioning culture to identity formation and workplace learning outcomes. Psychosocial pressures can restrict participation and learning, while organisational supports can enable access to tacit knowledge and central tasks. The feedback loop illustrates that as women gain legitimacy and expertise, they can influence and reshape commissioning culture, contributing to more equitable and expansive learning environments.

The framework generates specific testable propositions that can guide empirical investigation (see Table 1). These propositions specify the relationships between commissioning culture, credibility negotiation, participation patterns, learning outcomes, and the moderating effects of psychosocial and organisational factors

Table 1. Key Propositions for Empirical Testing

Domain/Relationship	Proposition
Culture → Credibility	P1: Commissioning cultures characterised by strong gendered norms and masculine workplace practices intensify credibility scrutiny for women engineers.
Credibility → Participation	P2: Women experiencing persistent credibility questioning are more likely to be assigned to peripheral tasks and less likely to access central problem-solving opportunities.
Participation → Learning	P3: Central participation in commissioning work (troubleshooting, decision-making, system integration) predicts greater access to tacit knowledge and experiential learning compared to peripheral participation.
Learning → Identity	P4: Access to tacit knowledge and successful participation in high-stakes commissioning tasks strengthens women engineers' professional identity formation and perceived legitimacy.
Moderator: Psychosocial	P5: Psychosocial pressures arising from marginalisation (including self-doubt and hypervigilance) reduce women's participation in central tasks, even when formal opportunities exist.
Moderator: Organisational	P6: Organisational supports—including mentoring, inclusive leadership, and explicit framing of commissioning as a learning environment—buffer against credibility barriers and expand access to developmental opportunities.
Feedback Loop	P7: As women gain expertise and legitimacy through successful commissioning experiences, they can actively reshape team cultures and learning climates, creating more equitable conditions for subsequent participants.

6. Implications for Workplace Learning Research and Practice

This framework identifies commissioning as an overlooked but high-value site for workplace learning scholarship and organisational practice. It generates implications across four domains:

6.1 Research priorities

The framework highlights several research priorities for workplace learning scholars:

- How credibility and professional identity shape access to experiential learning in high-pressure, time-critical environments
- How temporary, cross-functional team cultures influence women's participation and learning trajectories
- How psychosocial responses to structural barriers interact with learning opportunities and capability development
- How organisational interventions can design more inclusive and developmentally effective commissioning practices
- Comparative analysis of commissioning with other high-stakes learning contexts (e.g., medical residencies, emergency response, startup environments)

6.2 Commissioning team design

Engineering organisations can embed learning-focused structures in commissioning by:

- Establishing explicit learning objectives alongside technical deliverables at the start of commissioning phases
- Designing team composition intentionally to include women engineers in roles with central responsibility and decision-making authority
- Creating structured opportunities for knowledge sharing, such as daily debriefs where team members can articulate their diagnostic reasoning and learning
- Rotating high-value troubleshooting opportunities across team members to ensure equitable access to developmental experiences

• Documenting commissioning decisions and rationales to create learning artefacts that can be accessed by peripheral participants and future teams

6.3 Leadership and mentoring interventions

Leaders can prepare to recognise and support diverse participants by:

• Receiving training on how credibility biases operate in high-pressure technical environments and developing strategies to counteract them

• Actively monitoring participation patterns during commissioning and intervening when peripheral positioning becomes evident

• Establishing formal mentoring relationships that pair early- and mid-career women engineers with experienced mentors who can advocate for their involvement in central tasks

• Creating psychological safety through explicit norms that questioning, learning, and acknowledging uncertainty are valued behaviors during commissioning

• Recognising and publicly attributing women's contributions to problem-solving and system troubleshooting

6.4 Assessing commissioning culture

Organisations can evaluate whether commissioning environments support equitable learning by asking:

• Are learning objectives explicitly articulated alongside technical deliverables?

• Do women engineers have equitable access to central troubleshooting and decision-making roles?

• Are credibility judgments based on demonstrated competence or influenced by gendered assumptions?

• How are developmental opportunities distributed across team members?

• Do team debriefs create space for diverse perspectives and contributions to learning?

- Are mentoring relationships and leadership support structures in place to facilitate women's progression from peripheral to central participation?

These diagnostic questions provide a practical tool for organisational self-assessment and continuous improvement of commissioning as an inclusive learning environment.

6.5 Future research and empirical investigation

This conceptual framework establishes foundations for empirical investigation of women's learning in commissioning environments. Future research should test the framework's propositions through multiple methodological approaches:

- Quantitative surveys examining relationships between commissioning culture, credibility experiences, and learning outcomes across diverse engineering contexts
- Ethnographic studies documenting credibility negotiation and participation patterns during actual commissioning work
- Longitudinal research tracking women engineers' learning trajectories and identity development across multiple commissioning experiences
- Intervention studies evaluating the effectiveness of inclusive commissioning design, mentoring programs, and leadership training
- Comparative analyses exploring how these dynamics operate across different engineering disciplines, project types, and organisational contexts

Each approach offers distinct insights into the mechanisms proposed in the framework. Survey research can test relationships between variables at scale, identifying which factors most strongly predict learning outcomes. Ethnographic methods can reveal the micro-processes through which credibility negotiation unfolds in practice. Longitudinal designs can capture how learning trajectories evolve over time. Intervention studies can evaluate whether organisational changes produce the predicted effects. Together, these methods can build a comprehensive evidence base for improving women's workplace learning in commissioning and similar high-pressure technical environments.

7. Conclusion

Commissioning is a critical site of experiential learning in engineering, yet its learning dynamics—and especially women's experiences—remain largely unexamined. This conceptual paper positions commissioning as a workplace learning environment where credibility, identity, and culture intersect to shape learning opportunities. By identifying credibility negotiation as the key mechanism connecting culture to learning, the framework offers a new lens for understanding gendered participation in engineering work. It provides actionable guidance for creating more equitable and effective learning environments.

The framework contributes to workplace learning scholarship by extending theories of situated learning and communities of practice into high-pressure, temporary team contexts that have received limited attention. It demonstrates how informal learning processes—often celebrated for their authenticity and richness—can simultaneously reproduce inequities when credibility is distributed unevenly. For engineering organisations, the framework provides practical strategies for redesigning commissioning as an inclusive learning environment, with implications for talent development, capability building, and organisational performance.

Future empirical research should test the framework's propositions, document the mechanisms through which commissioning culture shapes learning, and evaluate interventions designed to improve equity and inclusion. By bringing workplace learning perspectives to bear on this overlooked phase of engineering work, scholars and practitioners can work together to create commissioning environments where all engineers—regardless of gender—have equitable access to the developmental opportunities that build expertise and advance careers.

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