2024 AAEE Award AAEE Project-Based Learning (PjBL) Team – Statement Addressing Criteria

Focus & Relevance

Project-Based learning (PjBL) is an approach that engages students in authentic learning experiences that have practical industry relevance (Blumenfeld et al. 1991; Herrington & Herrington 2006) and is defined by its central premise of a problem in the form of a project. PjBL promotes the development of graduates who will be prepared to contribute to society in line with Engineering 2035 (Lawrence 2020) and is a key mechanism to bring tasks that have relevance to graduate practice into the engineering curriculum. Benefits of PjBL include the development of professional skills and identity, including better communication and teamwork skills, as well as a better understanding of how to apply knowledge in practice and complexities of practice (Mills & Treagust 2003).

Nevertheless, there are significant barriers to improvement and wider adoption of practice-based approaches such as PjBL in Australian institutions (Crosthwaite 2021), including: the cost associated with scaling up projects for large cohorts; limited access to industry partners; appropriately qualified teaching staff; perceived resource-intensive requirements; challenges with engaging diverse cohorts; resistance to change; organisational structures; added difficulty in showing that these meet accreditation requirements. These barriers may result in inauthentic PjBL which will impact student experiences of realistic, authentic practice within the curriculum and reduce learning, and feed into workload concerns for educators who use PjBL (Brown 2020) which often leads to staff attrition in these types of units.

Given calls for expansion of this approach in Engineering 2035 agenda, our multi-institutional team's study was guided by the following research questions:

- What are the current practices and challenges in current PjBL practice?
- What are the barriers and enablers of current PjBL practice to meet the Engineering 2035 agenda?

To address research questions, the team focused on gathering desktop data from Australian & New Zealand universities to compare and share experiences of PjBL, as well as build an understanding of the support provided to the educators of PjBL units. We collected empirical data from 66 units across 15 universities and conducted interviews with PjBL unit coordinators and industry partners.

Significance

Our research addresses a significant gap in the engineering education discourse, by:

- benchmarking PjBL practices, with respect to student numbers, assessment types, resource allocation (academic workload and cost per unit) and industry engagement
- defining strengths of PjBL through evaluating feedback from multiple stakeholder perspectives, including industry partners and course convenors
- quantifying sustainable practices and support for Schools, Faculties and Teaching & Learning (T&L) leadership to retain educators for these PjBL units

The outcomes of this research have had a substantial influence on the integration and sustainability of PjBL in engineering education, directly shaping the competencies of future engineers to meet the complex demands of the modern engineering sector. This research has enabled engineering educators to better understand how their inputs, practices, and institutional contexts, such as resource commitments, compare with PjBL units delivered elsewhere. Institutionally, PjBL units had previously been compared to units that used different approaches. The findings from this research now allow for a more accurate like-for-like comparison, further enhancing the understanding and implementation of PjBL in engineering curricula.

Context & Contribution

Our study is firmly embedded within the interdisciplinary frameworks of engineering and broader educational research. This includes the frameworks established by institutions like the Aalborg Centre, which was explicitly established to promote PjBL in engineering worldwide, and aligns global educational objectives outlined by UNESCO (United Nations Educational et al.).

Our research is strongly aligned to concerns around embedding opportunities for authentic engineering practice into the engineering curriculum as outlined by the ACED Engineering Futures 2035 reports (Crosthwaite, 2019; Lawrence, 2020; Crosthwaite, 2021). In Stage 2 Recommendation 2, Crosthwaite (2019) suggests a strong need for:

- a desktop review of global best and emerging practice to develop guidelines and exemplars of new and renewed engineering education programs
- better integration of the potential impact of engineering practice
- stronger interaction with professional practice contexts
- embedding external industry
- use of open-ended projects in engineering programs

In response to these recommendations, this study focuses on better understanding best practice in the delivery and support of project-based learning (PjBL) units, which not only draw on authentic practice but also build connections between professional and technical competencies.

Prior to our research, there had been no equivalent study which explored such depth or developed a broad set of recommendations tailored to key stakeholders, including industry, unit coordinators, and deans. This novel approach has allowed us to identify specific needs and gaps within the current educational practices, offering a robust framework for enhancing PjBL implementations.

Contribution

This research contributes to education research and practice by:

- confirming and consolidating findings from a range of publications on individual experiences of PjBL (e.g. Tse and Bona 2019; Brown 2020) and providing evidence of shared challenges amongst PjBL offerings that cannot be addressed by unit coordinators individually
- providing insights into sustainability and scalability of PjBL, particularly contributing knowledge on scaling for large class sizes and articulating sustainability as a base requirement for scalability

providing tangible data and recommendations to support decision-making around academic support To date, this work has:

- made the successful case for a national-level investment by the Australian Council of Engineering Deans in supporting PjBL delivery via the Engineering Futures Initiative
- been used in teaching impact cases by educators delivering PjBL units
- generated ongoing interest in contributing benchmarking data for PjBL units internationally
- produced one conference paper (Ranaraja et al. 2022) and two open-access journal papers (Miao et al. 2024a, Miao et al. 2024b).

This research also contributes to the growing body of work that highlights the lack of sustainability in T&L practice more broadly. In an invited presentation to the University of Sydney Educational Innovation team (educational designers and academic developers who service the entire university) in 2024, this research was used to explore: the challenges that teaching academics face; why academics might not engage with top-down attempts at innovation; and the value of support mechanisms (including colleagues) in driving

improved T&L practice. Feedback noted the importance of this research in highlighting considerations impacting effective collaboration with teaching academics:

> *The presentation challenged me to re-evaluate my underlying assumptions and approach when working with academics so we can collaborate to co-design relevant and practical improvements to their teaching practices.*

Research Design

The team members are from five Australian universities that have experiences in PjBL units and of varying disciplines, wanting to deep dive into research questions of PjBL practices across Australia and New Zealand. There is great demand of this evidence-based research to support academic staff for improving the administration and operation of PjBL units. As summarised in Figure 1, we employed a mixed-methods approach to gain a broad overview of the PjBL landscape and a deep understanding of the experiences of PjBL stakeholders.

The first component of our research design was a desktop study, collecting data on PjBL units across Australia and New Zealand from 66 PjBL units across 15 Australian and New Zealand universities. This enabled us to identify current practices based on course design philosophy and format, project focus, delivery and assessment modes, staffing ratios, staff experience/background, industry and community engagement and outcomes of student satisfaction survey. Statistical methods were used to identify not just the statistical significance of relationships in the data, but also effect sizes (i.e. the practical implications of the relationships).

The second component of our research design involved interviews with 7 unit coordinators and 6 industry-based PjBL collaborators. We drew upon the data analysis and findings from the desktop study to identify key areas to explore in more detail through these interviews. These interviews aimed to capture deeper insights into the practical implementation of PjBL, challenges faced by educators and collaborators, and the perceived effectiveness of these initiatives in real-world settings. We analysed this interview data using thematic analysis to identify key areas that impact the design, delivery and implementation of PjBL. This also subsequently informed the presentation of our desktop study findings under these themes.

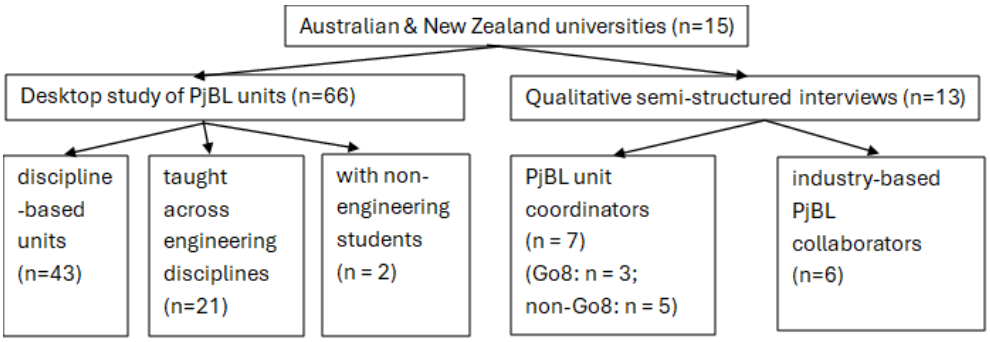

Figure 1: Summary of research methods

Research Validity

The combination of quantitative and qualitative approaches enhances the credibility and dependability of our findings. In having directly engaged with those who coordinate and collaborate on these projects, we have gathered rich lived experiences that validate and enhance the statistical data obtained from the desktop study. This approach not only ensures that our findings are grounded in actual educational practices but also enhances the transportability of our research outcomes, providing valuable insights that can be applied to similar educational settings internationally.

To validate our results, we organised and conducted an AAEE conference workshop (with over 90 participants in hybrid mode) and an in-person AAEE networking event (with 20 attendees). The discussions with PjBL academics at these events confirmed that our results resonated with their experiences and provided useful data to benchmark their practice, with an attendee contacting us afterwards:

I attended your presentation on Wednesday morning at AAEE 2022 on project-based learning (PjBL). I enjoyed the paper very much and found it had a lot of helpful information and it described well the state of the art on PjBL. I am looking into transferable skills education and Engineering Futures 2025 into which PjBL is an important component.

This was further confirmed by several colleagues who saw the value of this project's contributions to PjBL and subsequently reached out to contribute to the study after these sessions.

The credibility of our findings is evidenced by the alignment of our findings from the broader Australian and New Zealand context with existing literature on individual experiences of PjBL (e.g. Tse and Bona 2019; Brown 2020). Moreover, this is supported by the positive feedback received both formally through journal paper reviews and informally through peers and invitations to present at T&L fora, including:

- UNSW Education Festival Forum 2021. "C*urrent Practice in Engineering Project-Based Learning across Institutions*"
- WSU Learning and Teaching Day 2022. "*Current Practice in Engineering PjBL across institutions*"
- UTS Centre for Research in Engineering and Information Technology Education (CREITE) presentation 2023. "*Current best practice, support mechanisms and experiences of project-based learning*"

Results

The findings of this study present a useful snapshot of contemporary norms in PjBL within the Australian & New Zealand context, as well as next steps of how to sustain and scale PjBL use in engineering curricula.

Although there are some degrees overseas that are entirely PjBL, it is far more typical to find intermediate models in Australia & New Zealand. There is much variety in the focus of projects that are used, the rationales for using PjBL and approaches to PjBL. Moreover, despite increasing interest in interdisciplinary projects, our study only identified two units (at the University of Sydney and the University of Melbourne) where non-engineering students were involved and both are elective units run in conjunction with a business unit.

PjBL is used by academics across all levels; however, junior academics (Levels A–B) have greater student numbers than senior academics (Levels C–D). The tendency for larger, junior units to be coordinated by junior staff appears to be a widespread and long-standing occurrence across Australian & New Zealand universities. This is concerning as junior staff in engineering faculties often feel powerless to change teaching culture at their institutions (Kavanagh et al. 2012) and often don't have the agency to seek appropriate resourcing. This is exacerbated by leadership often being reluctant to offer this resourcing and a lack of clarity around budgets.

Coordinators have highly variable experience in industry. Whilst 33% of coordinators have no industry experience, 46% of coordinators have significant industry experience (>5 years). Most units in this study (n = 50) contain projects based on real-world problems that are determined by the coordinator. Of these units, 29 were run by a coordinator with less than 5 years of industry experience, highlighting a need to have greater direct involvement of industry partners to ensure authenticity of learning practices. Industry are keen to be involved, but there are institutional and personal constraints that need to be considered when drawing upon them.

The total unit workload hours (coordinator + sessional staff) increase with cohort size. On average, resourcing of 3.5 hrs per student is allocated for PjBL units. This is not to say that this is appropriate resourcing, but it is what is provided to PjBL coordinators. The mean coordinator workload is equivalent to 0.4FTE; however, some coordinators reported workloads of >1FTE, highlighting workload issues. Workload was one of the most common concerns raised by coordinators and can lead to staff attrition, with one interviewed coordinator indicating that they had plans to leave for industry due to workload concerns. Co-coordination models were not common (n = 8), but collaborative teaching was highlighted as key approach to managing contingency, reducing workload concerns and increasing psychological safety.

Multi-disciplinary courses have lower student satisfaction than single-disciplinary courses on average. They tend to have a greater focus on non-technical competencies, and there can be resistance to the complexity

of project work (Goldfinch et al. 2019; Willey & Matchet, 2018). Students are often far more appreciative of such units with hindsight, which is not reflected in student satisfaction scores. More work needs to be done to better communicate to future engineering students the important role that PjBL plays in developing industry-ready graduates.

Key recommendations highlighted by this study are:

- the sustainability of PjBL needs to be addressed by T&L leadership to drive wider adoption
- unit coordinators can use enablers of PjBL practice to identify suitable practices within their own contexts and/or for advocacy with their own T&L leadership
- T&L leadership should consider: providing better resourcing; providing sufficient time for coordinators to build connections and design their units appropriately; giving academics the freedom to design project units as required; introduce co-coordination models; and building a shared understanding of how to interpret student feedback.

The significance of these results and recommendations is in:

- equipping unit coordinators with mechanisms that can support them in PjBL practice
- equipping Learning & Teaching leadership to consider implementation and support of enablers not currently implemented at their institution, and review which of the barriers they can address
- highlighting sustainability as a key driver of scalability, putting the focus on Learning & Teaching leadership addressing sustainability issues to improve the scalability of PjBL
- providing insights into overcoming barriers that arise at scale, which enhances PjBL delivery for cohorts of any size and has practical implications for PjBL not only in Australia and New Zealand, but also internationally

Summary

This research has made a positive contribution to PjBL not just within Australia & New Zealand, but also internationally. We have engaged in stakeholder engagement and dissemination continuously through the years, including:

- two open access journal papers (Miao et al. 2024a; Miao et al. 2024b)
- an AAEE conference paper (Ranaraja et al. 2022)
- delivery of a AAEE workshop and networking event (110+ participants)
- multiple presentations (total 150+ attendees)
- an invited presentation to ACED (30 attendees)
- an invited presentation to the University of Sydney Educational Innovation team (35 attendees)

The significance of this research lies not only in the value of the data and findings themselves, but also in the usefulness of the data in empowering PjBL academics to seek enhanced support. Additionally, it provides a benchmark for their practice, which they can use in discussions with leadership and in showcasing their achievements to promotions panels. This is also clear in the continued interest from academics in contributing to the expansion of this snapshot of PjBL and broadening this work to compare Australian and New Zealand PjBL with international approaches.

References

Please see Additional Information for full reference listings.