Relational, place-based learning for the energy transition through the application of social frameworks

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Abstract

Engineering graduates are increasingly employed in the diverse aspects of the global energy transition, with a corresponding rise in university courses focusing on sustainable energy. However, the contemporary energy landscape is ever-changing, and is part of a large, complex system of technological, social, political and financial dimensions. This creates a challenge for educators in being able to connect complex, interdisciplinary topics to student learnings and the graduate outcomes that are valued by employers. Addressing these complexities requires innovative educational strategies that promote interdisciplinary collaboration and sustainable leadership. Drawing on principles of relational learning and interdisciplinary engagement, this paper explores place-based learning approaches in postgraduate energy courses. In many educational settings, direct engagement with communities may not be viable, so this paper evaluates the use of social frameworks to facilitate students' place-based understandings and learnings.

The paper employs a case study of a sustainable energy course at The University of Queensland to explore this effectiveness, using evidence from student surveys and feedback from the tutoring team. The case study analyses a place-based assessment piece on the transition to renewable energy in remote Queensland Indigenous communities, developed in collaboration with the state energy company. The application of social frameworks, specifically the Energy Services Cascade, the Sustainable Livelihoods framework and the Business Model Canvas, facilitated students' analyses of this unique place setting. Student surveys and tutor feedback showed that this approach enabled the development of a shared understanding of complex issues accompanied by inclusive, interdisciplinary teamwork. Some student feedback on the community setting indicated a degree of unfamiliarity with the specific contexts, highlighting the need for deliberate place-based knowledge sharing. This work showcases the utility of authentic place-based assessment and the application of frameworks in engineering education to address global sustainability challenges.

1 Introduction

1.1 Sustainability Leadership in the Energy Transition

The transition to sustainable energy, as part of a global Net Zero carbon future, can be characterized as a "wicked" issue, with complex trade-offs required between energy security, equity and sustainability. Motivated and diverse engineering graduates are required to analyse options and lead this transition, across communities, regions and nations. In this setting, a distinctive theory and practice of sustainability

leadership have emerged (Shriberg & MacDonald, 2013). This represents a more inclusive, balanced, and deliberate process of influence in engineering education that aims to deliver direction, alignment, and commitment to address social, environmental, and economic issues (Blickley et al., 2013). The principles of sustainability leadership highlight the importance of cross-boundary networks and engagement with stakeholder perspectives, as well as systems thinking and facilitation skills to respond to complexity (Allen, 2021). Teaching these skills to new sustainability leaders who are involved in the energy transition requires innovative higher education pedagogies (Beagon et al., 2023) with a focus on authenticity and multiple perspectives. Combining experiential and place-based learning approaches have previously demonstrated positive outcomes for students' learning of the complex issues involved in sustainability (Heinrich et al., 2015; Savage et al., 2015). It has also been shown to support critical thinking around the complex technological, social, political and financial decisions that need to be developed by future leaders (Allen, 2021).

1.2 Relational, Place-Based Learning

Curricula in higher education that emphasise sustainability leadership frequently incorporate project-based learning and promote active engagement with industry (MacDonald & Shriberg, 2016), enabling learners to grapple with the complexity of sustainability challenges. These pedagogical approaches can be grounded in authentic, experiential learning, wherein learners participate in realistic simulations that integrate theoretical knowledge with practical application (Boud & Prosser, 2002). Collaborative work involving individuals from diverse backgrounds fosters the cross-pollination of ideas, leading to more nuanced and comprehensive perspectives. These educational strategies are particularly well-suited to cultivating the adaptive knowledge and skills required in the rapidly evolving energy sector and broader sustainability challenges. Moreover, the combination of experiential learning and reflective practice supports the development of deep, enduring learning that informs and enhances professional practice (Ayers et al., 2020).

Place-based, relational learning represents a complementary pedagogical approach that emphasizes the importance of local contexts, community engagement, and the interconnectedness of social and ecological systems. This model encourages learners to develop a sense of place and responsibility through engagement with local environments and communities, fostering a deeper understanding of sustainability as a lived and situated experience (Gruenewald, 2003). This understanding of place is best developed through direct engagement with communities and the cultivation of meaningful relationships (Warr Pedersen et al., 2017) – but this is often not possible in educational contexts, especially with larger class sizes. Nevertheless, by embedding learning within specific geographic and cultural contexts, place-based education enables students to critically engage with real-world sustainability issues in a manner that is both personally relevant and socially responsive (Semken & Freeman, 2008). This approach not only enhances cognitive and emotional engagement but also supports the development of ethical and place-responsive leadership, which is increasingly vital in addressing complex sustainability challenges.

1.3 Social Frameworks as Analysis Tools

In designing the analytical tools to help student engagement with the complexity of place-based settings, frameworks commonly used in development studies and social science were evaluated. These included multi-level perspective (MLP) theory and the technological innovation systems (TIS) framework. While these offered useful insights, it was felt that they were overly complex and abstract to support the relational analysis necessary for place-based learning. Ultimately, three complementary frameworks were selected:

the Energy Services Cascade (ESC), the Sustainable Livelihoods Framework (SLF), and the Business Model Canvas (BMC). These were chosen for their accessibility, adaptability, and relevance to the lived realities of communities undergoing energy transitions. Together, they provided a holistic and scaffolded approach to engage with both technical and societal dimensions of sustainability.

The **Energy Services Cascade** facilitates a layered understanding of how natural and societal structures providing energy access translate into developmental outcomes, by tracing connections to energy services aligned with the values of a particular socio-economic context (Kalt et al., 2019). This is particularly relevant in place-based contexts where learners assess the real-world implications of energy interventions within specific communities. The **Sustainable Livelihoods Framework** provides another analysis tool by highlighting the interconnections between various forms of capital – natural, human, social, physical, and financial – and how these are influenced by institutional structures, vulnerabilities, and livelihood strategies (Chambers & Conway, 1992; Scoones, 2015). This provides students with the opportunity to critically examine how sustainability initiatives interact with local capacities and constraints. Meanwhile, the **Business Model Canvas** provides a structured lens for evaluating the business viability and scalability of solutions developed in these contexts by mapping value propositions, customer segments, infrastructure, and revenue streams (Osterwalder & Pigneur, 2010).

By triangulating these three frameworks, course designers envisaged that students would be able to develop integrated analyses that went beyond technical feasibility to consider community needs and long-term sustainability. The frameworks served as scaffolds that encouraged interdisciplinary thinking, respectful engagement with place, and the development of context-sensitive energy solutions.

1.4 Objectives of This Paper

This paper outlines a case study of a place-based assessment piece using social frameworks as its principal analysis tool. The context of the assessment piece is a course on Energy and Development within the Master of Sustainable Energy, a unique multi-disciplinary program offered by the School of Chemical Engineering at The University of Queensland. The course is delivered synchronously to both internal (on campus) and external (online) students via an intensive teaching period, followed by workshops and course assessment. The place-based assessment activity involves the development of a community energy proposal for a remote Indigenous community in Queensland, Australia, with the project brief developed in collaboration with a state electricity company. Students use the social frameworks to understand the social context of the community and its existing use of energy, enabling them to develop an authentic energy proposal. A key focus is on a consultative approach to stakeholder perspectives.

Through anecdotal observations and student surveys, the paper evaluates the efficacy of place-based learning and the utility of the social frameworks to distil the complexities of these unique communities. The results of the case study show that the place-based learning and the framework tools are well received by students, with positive self-assessment scores for the ability to conduct energy proposals and understand stakeholder perspectives. The results also reveal some student reservations with place-based learning in contexts that are quite unfamiliar to the majority of students, with information-gathering limited to that which is publicly available. The paper also reflects on broader challenges and opportunities of this pedagogical approach and provides some recommendations on the potential of place-based learning in addressing global sustainability challenges in engineering education.

2 Methodology

2.1 Case Study of Place-Based Assessment: Community Energy Proposal

The case study involves the use of an authentic place-based assessment piece, with the project brief developed in collaboration with a state electricity company. Student teams were tasked with developing a hypothetical energy solution for a remote Queensland Indigenous community in Australia, consistent with the company's strategy and the transition from diesel power generation to renewable energy systems. Teams prepared a report detailing their energy solution and detailed implementation strategy, with the intended audience being key community stakeholders and the electricity company. The reports included an assessment of the appropriateness of the chosen energy solution, as well as specific community interpretations of the energy services cascade, the sustainable livelihoods framework and the chosen business model canvas.

Information presented to students to conduct the assessment piece included an assignment brief with task instructions. However, information on the communities was left for students to source, largely from publicly available information accessed via internet searches. Learning modules for the course also included a guest presentation from the electricity company's networks manager, which provided students with insights into the policy drivers and corporate approaches to the energy transition in remote Queensland communities. Other learning modules in the class provided lecture content on appropriate technology, stakeholder engagement and an introduction to each of the three social frameworks, as well as information on Australian Indigenous history and culture.

2.2 Assessing the Effectiveness of the Learning Initiative

Students completed a survey in early 2025 as part of a larger ongoing review of the Master of Sustainable Energy program. The study had ethics clearance from The University of Queensland (ethics number 2024/HE001996). The survey included students' ratings of the degree to which they had achieved the course learning outcomes; ratings of how well the course delivery met their needs; and self-efficacy ratings about confidence in their abilities related to the skills and aptitudes targeted by the course. Demographic questions included student status (domestic or international and full or part-time) mode of attendance (virtual or face-to-face) and whether this was their first semester of study in the program. Rating questions were answered on a five-point Likert scale from 1 (*Strongly disagree*) to 5 (*Strongly agree*) for most questions. The self-efficacy questions used a 100-point scale adapted from Bandura (2006), from 0 (*Cannot do at all*), through to 100 (*Highly certain can do*).

Fifteen students completed the survey. Most students completing the survey were international students (8) and most were studying full-time (13). For most students this was their first semester of study in the MSE, with the majority studying on campus.

3 Results

3.1 Student survey results

Only results relevant to this study are reported here. The key results are presented in Table 1 below. Students rated the item "The use of frameworks has allowed me to maximise learning outcomes" at an average of 4.21 (SD = 0.80). The Community Energy Proposal was rated slightly lower at 4.14 (SD = 0.95). The choice of setting – in this case, a remote Queensland Indigenous community – received a lower rating.

Table 1: Students' rating of key items of interest

Item	Average	Standard Deviation
The course has provided me with multi-disciplinary perspectives	4.33	0.62
The use of frameworks has allowed me to maximise learning outcomes	4.21	0.80
The Community Energy Proposal provided an authentic, place-based learning experience where I could develop an understanding of social impacts and community engagement	4.14	0.95
The setting of the Community Energy Proposal in remote Queensland Indigenous communities provided an authentic learning environment to develop competencies related to social impacts and community engagement	3.93	1.00

Students' qualitative or text-based comments about the place-based learning aspects of the course were generally positive. For example, students made statements such as:

- *'I have gained a broad perspective and understanding of engaging with different stakeholders, especially the local communities. Additionally, the systems thinking which includes the positive and negative feedback loops is a very useful tool for project development'.*
- *'It gives a different edge to consider when analysing an industrial project, including renewable ones, which can have many impacts on local communities as well. Additionally, understanding the energy trilemma and thinking about addressing it was very interesting'.*
- *'The use of real-world case studies and simulations helped bridge the gap between theoretical concepts and their practical applications'.*

However, there were students who did not see the value of the place-based approach to their learning, as evidenced by the following student comment:

- *'I felt there was too much emphasis on remote and Aboriginal communities. Many renewables projects in Australia are being delayed/falling over due to issues and failure to get social licence to operate. It seems the majority of these are not related to remote and Aboriginal communities. So in terms of how to engage communities and a structured approach to achieve social licence to operate, I think that it would be more beneficial if there was a greater emphasis on metro and rural Australian communities'.*

Students rated their self-efficacy to complete skills and abilities relevant to the course highly (Table 2). For all statements, students' self-efficacy ratings averaged between 70 (on the higher side of *Mostly certain can do*) and 81 (*Highly certain can do*).

Table 2. Students' self-efficacy ratings for skills and abilities developed in the course

I feel confident that I could…	Average	Standard Deviation
Consider community contexts and develop best-practice communication and engagement strategies, as part of an energy project	80.91	12.09
Work effectively in a multidisciplinary team	79.55	20.42
Analyse the stakeholder, cultural, environmental, and business implications of energy proposals	77.91	13.55
Advise various levels of government about the trade-offs of the energy transition and ways to contribute to the Sustainable Development Goals.	76.55	15.13
Develop a Community Energy Proposal	75.09	15.08
Apply a systems approach to examine and critique the connectedness, consequences and trade-offs of the energy transition	74.18	15.38
Apply multidisciplinary frameworks (e.g. the Energy Services Cascade or the Sustainable Livelihoods framework) to understand a given community and its engagements with, and responses to, the energy transition	72.00	11.61
Analyse and advise on appropriate technologies to support the energy transition in communities and regions	71.82	20.07
Advise on business models to provide viable, long-term strategies for community energy projects	70.82	14.40
Contribute effectively to the energy transitions in remote Indigenous communities	70.64	19.63

3.2 Tutor anecdotal review

Anecdotal feedback was sought from the tutoring team, which showed positive sentiments to the place-based learning activity employing frameworks:

- *'The use of frameworks supported students to distil information about an unfamiliar context and link this information to energy service provision. This facilitated the development of critical thinking skills is essential for students to learn how to tackle the complex problems associated with solving energy solutions for communities'.*
- *'The frameworks help the students to navigate the complexities of communities by fixing scopes and areas for analysis. Moreover, the frameworks' inter-connectedness allowed students to see social needs of the community and consequences on livelihoods of changes from the status-quo'.*

4 Discussion

4.1 Pedagogical Challenges and Recommendations

The findings indicate that students agree that the course has developed their interdisciplinary or multidisciplinary perspectives. They also indicate that students see the value of the social frameworks as a tool for understanding and analysing community contexts. Students also appear to have high self-efficacy

in the skills and abilities that they have developed through the course. Students do however appear to be less certain about the place-based aspects of the course. This may be due to students not seeing the transferability of the skills developed in their study of remote Indigenous communities, to other contexts. In future iterations of the course, skills in stakeholder engagement could be emphasised as transferable across multiple contexts. Helping students to make this connection is critical, both for students' professional development and also for the energy industry, where skills shortages are apparent in community and stakeholder engagement (McCoy et al., 2024).

The lowest self-efficacy rating related to students' effectiveness in contributing to the energy transition in remote Indigenous communities. This could be related to the communities' complex, unfamiliar socio-economic conditions that may be outside the "comfort zone" of the majority of students. There is evidence that students obtain better learning outcomes when the problem context is more familiar to them (Soppe et al, 2005). Additionally, students need time to interpret and "manage the inherent complexities and uncertainties implicit in societal challenges" (Hitt et al., p. 4, 2025). Students were largely self-directed in their knowledge-gathering about communities, using publicly-available, mostly online, information. More deliberate place-based knowledge sharing, including guest lectures by community members, would greatly assist this contextual understanding. In addition, having a variety of place-based options, perhaps through a scaffolded approach to case studies, may assist in improving students' sentiments related to effectiveness.

5 Conclusion

Overall, this paper has evaluated place-based assessment for engineering students who are increasingly employed in the diverse aspects of the global energy transition. While the mix of approaches and social frameworks used has been largely validated, the results have also provided some areas for reflection. Authentic place-based contexts, as real, complex environments, have varying degrees of student familiarity. In the absence of direct engagement with communities, making time for place-based knowledge sharing may assist with understanding, especially for community contexts that most students would not have conceptualised. These findings reinforce the challenges of creating authentic learning environments, as examined by Strobel et al., (2013) and Chen et al. (2020).

Nevertheless, the use of social frameworks in place-based and relational learning approaches was found to provide students with appropriate tools to begin to understand the social contexts and foster their connections with industry and diverse communities. Such frameworks seem particularly useful in allowing engineering students to go beyond technical considerations to address the crucial role that engineering plays in addressing society's needs. Further relational and interdisciplinary approaches will continue to be critical to provide authentic learning experiences to support society's energy transition.

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