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# The Sustainable Homes Challenge: Pedagogical and employability benefits and challenges of participating in an interdisciplinary applied design project

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## ABSTRACT

### CONTEXT

To prepare for a career as a professional engineer, students need to: be able to work in multi-disciplinary teams; have highly developed communication skills; and be skilled in problem finding and solving. The literature suggests that applied multi-disciplinary team projects provide students with an opportunity to work on these skills. The Sustainable Homes Challenge (SHC) 2021 was an extra-curricular challenge which brought together students from six Australian Universities, and from a broad range of disciplines, both engineering and non-engineering, to tackle the problem of designing a sustainable, affordable and healthy home from waste-derived products.

### PURPOSE OR GOAL

An evaluation of the SHC was conducted with a view to transforming it into a subject within the curriculum. The aim of this research was to explore the experiences and perceptions of both student and mentor participants of the SHC 2021 in order to understand the potential pedagogical and employability benefits for students, and identify appropriate ways to improve the Challenge.

### APPROACH OR METHODOLOGY/METHODS

An online questionnaire survey was conducted with both student and mentor participants of the SHC 2021. Descriptive and thematic analysis of the survey data was conducted. Key topic areas from the survey results were explored in greater depth through a subsequent focus group with student participants. The data from the focus group were analysed using thematic analysis.

### OUTCOMES

Participants identified significant benefits of working in a real-world environment including: an ability to work within diverse teams and enhanced critical thinking and problem-solving skills. Interdisciplinarity posed challenges including rationalising diverse approaches and skillsets. However, a shared connection around sustainability was found to help overcome these obstacles.

### CONCLUSIONS/RECOMMENDATIONS/SUMMARY

The SHC was perceived as a positive experience for all involved, in particular the engineering students, for whom the interdisciplinarity developed their understanding of diverse perspectives. Other employability benefits included real-world alignment of outputs required from the Challenge. Increased industry involvement throughout would improve the outcomes of the Challenge.

### KEYWORDS

Multi-disciplinary teams; transferable skills; real-world experience.

# Introduction

In Australia, we are increasingly living with the impacts of human-induced climate change (IPCC, 2022). Over 65% of Australia's direct greenhouse gas emissions are as a result of engineering activities (Engineers Declare Australia, No Date). It is therefore critical that we prepare our next generation of engineers to tackle these contemporary societal challenges (Van den Beemt et al., 2020). Previous research has identified interdisciplinary collaborative learning as critical within architecture, engineering and construction (AEC) education (Soetanto, Childs, Poh, & Glass, 2017; Van den Beemt et al., 2020), and even more so when dealing with the complex economic, social and environmental imperatives in mitigating climate change (Bunting et al., 2007). Australian employers of engineers have identified the need for engineering graduates to: be able to work in multi-disciplinary teams; have highly developed communication skills; and be skilled in problem finding and problem solving (ACED, 2021). The literature suggests that applied projects in which students work in multi-disciplinary teams provide an opportunity to work on these skills (Sharma, Steward, Ong, & Miguez, 2017; Soetanto et al., 2017), and that greater diversity in teams leads to improved outcomes (Adya, Temple, & Hepburn, 2015). Furthermore, embedding real-world experience within learning and teaching is believed to improve student engagement and lead to enhanced employability (Macfarlane & Tomlinson, 2017).

The Sustainable Homes Challenge (SHC) is an extra-curricular challenge, conceived of and hosted by a multi-disciplinary team of academics at the University of Wollongong. The inaugural SHC ran in 2021, between July and December. Invitations were sent to 16 Australian Universities calling for applications from student participants in a broad range of disciplines, both engineering and non-engineering. 30 students from six Australian universities were selected and placed in teams, purposively chosen to maximise diversity in the teams. Over five months, they were challenged to create a design proposal for a sustainable, healthy and affordable home using innovative components made from waste-derived materials. Designs were required to maximise benefits to householders and the wider community, while minimising waste and negative impacts on our planetary ecosystems.

Students were provided with a baseline design for a home by a Community Housing Provider. They were then required to define a building occupant for their home, develop a detailed concept design and address sustainable, healthy and affordable evaluation criteria. Over the course of the project, students were provided with 10 weekly online modules to work through to develop both their team dynamics and their understanding of the core aspects of the design process. Topics included teamwork, problem definition and pitching as well as technical areas such as the circular economy, life cycle assessment and sustainable building design. Modules were designed to be simple enough to be understood by non-AEC students, but also to provide sufficiently challenging and interesting learning for those with experience in this area. The online modules were complemented by discussion sessions, guest speaker seminars and workshops to engage students further. Teams were required to present a 10-minute pitch at the conclusion of the Challenge highlighting the key features of their design, a poster and detailed content uploaded onto a publicly accessible website (https://www.uow.edu.au/engineering-information-sciences/sustainable-homes-challenge/).

As the students involved in the Challenge were located across Australia, all content throughout the Challenge was delivered online through the use of the UOW Moodle platform, utilising the software Articulate Rise to develop interactive learning content. The intention was for students to be brought together for an in-person finale week, however Covid restrictions meant this was not possible. Instead, the finale was held online, and an in-person reunion was held in early 2022.

Students were asked to nominate an academic mentor from their home institution to provide guidance and accountability. It was expected that mentors would meet with students once a month to discuss progress.

The inaugural SHC was held in a very difficult semester, characterised by strict Covid lockdowns in NSW and Victoria. This provided significant challenges to the students involved, and consequently some of the selected students were unable to continue the Challenge through to completion.

Nevertheless, each of the 5 teams was able to produce high quality outputs that were presented to a panel of industry and academic judges, receiving very positive feedback. Moving forward, work is being undertaken to convert the extra-curricular challenge into an inter-disciplinary subject to extend its reach and provide more sustainable and tangible outcomes for the students involved.

The aim of this research was to explore the pedagogical and employability benefits and challenges for interdisciplinary applied learning through an evaluation of the SHC. To achieve this aim, the following objectives were established:

- Investigate the perceptions of students and mentors in terms of the skills and knowledge that the students developed through the process of working as an interdisciplinary team.
- Investigate the perceptions of students and mentors with respect to the challenges faced by the students whilst working as an interdisciplinary team.

## Methods

In order to explore the pedagogical and employability benefits and challenges of this interdisciplinary applied learning experience, and to evaluate the SHC 2021 with a view to developing a curriculum-embedded subject, a two-stage methodology was employed. First, an online questionnaire survey was conducted with both student and mentor participants during December 2021, at the conclusion of the Challenge. Subsequently, key topic areas from the survey results were explored through a focus group with student participants.

After the finale week, the participants were invited to complete an evaluation survey comprising 35 questions. 26 of these questions were Likert scale statements in which participants were required to indicate their level of agreement with statements based on a six-point scale from Strongly agree to Strongly disagree. The discipline of the student's degree and their prior experience/knowledge relating to sustainable home design were also captured. The final seven questions invited open-ended qualitative responses. These open-ended questions focused on the skills and knowledge developed as a result of participation in the SHC/working in a multidisciplinary team. The Likert scale questions were derived from a review of teaching evaluation questions gathered from a range of Australian universities. They covered aspects of: learning content, group work, diversity, workload, work integrated learning, online resources and alignment with the UN Sustainable Development Goals. Data from the surveys were analysed using descriptive and thematic analysis.

A 90-minute student focus group was conducted during a reunion week held in early 2022. The focus group explored issues identified by the SHC delivery team and the topics of greatest agreement and divergence within and across the respondent groups based on the analysis of the survey results. Data from the focus groups were analysed using thematic analysis.

## Results

### Research participants

From the 25 invitations sent to student participants of the SHC 2021, 12 responses to the survey were received (48% response rate). Five of the respondents were studying Engineering, one was studying Architecture and the remaining six students were studying other (non-AEC) degrees. This was somewhat representative of the final SHC cohort which comprised 44% engineering, 20% architecture and 36% other students.

19 mentors were invited to complete the survey, with 11 mentor responses received. From the survey respondents, five mentors research/teach within an Engineering Faculty; one within an Architecture Faculty; and the remaining five within other (non-AEC) Faculties. This aligns closely with the degree disciplines of the student survey participants.

From the 18 students who attended all or part of the reunion week, 9 SHC student participants chose to take part in the focus group. There was no requirement to have completed the survey in order to take part in the focus group, and due to the anonymity of the survey, the level of cross-over between the two forms of data collection is unknown.

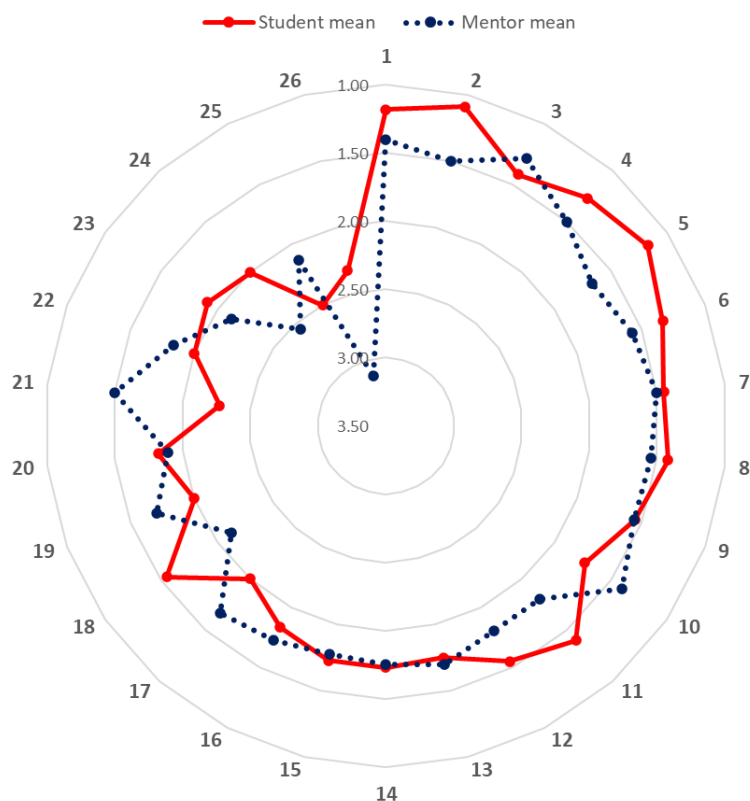# Quantitative survey responses



**Figure 1: Likert scale means for Student and Mentor groups - All questions (*mean 1.00 aligns with 'Strongly agree'; mean 3.00 aligns with 'Mildy agree'*); Question key below (*presented in rank order*).**

| | | | |
|---|---|---|---|
| 1 | Improved student's ability to work in a multi-disciplinary team | 14 | The online resources and activities were valuable for student's learning |
| 2 | Improved student's ability to appreciate diverse views from other people | 15 | There was effective collaboration between group members |
| 3 | Provided real world examples that helped student to connect theory and practice | 16 | Student understood the requirements and learning outcomes for the SHC |
| 4 | Student was able to make a worthwhile contribution to the group project | 17 | The content was organised in a clear and logical way |
| 5 | The learning materials aided student's learning | 18 | Learning activities were effective in developing student's understanding |
| 6 | The technology used aided student's learning | 19 | The learning activities created opportunities for student to learn from their peers |
| 7 | The online resources were of a high quality | 20 | Improved student's ability to apply knowledge of the UN SDGs |
| 8 | Challenged student's thinking | 21 | Raised awareness of issues regarding equity and diversity |
| 9 | The learning materials related well to real life situations | 22 | Has a learning environment that takes into account student diversity |
| 10 | Aligned with the UN SDGs | 23 | The online learning activities helped student to succeed |
| 11 | Improved student's job-related or work-related knowledge and skills | 24 | The workload was realistic and appropriate |
| 12 | Improved student's ability to solve complex, real-world problems | 25 | Student received timely feedback that was helpful to my learning |
| 13 | Overall, I am satisfied with the SHC | 26 | Information about tasks was clearly stated |

Figure 1 shows a comparison of the mean scores across the student and mentor groups for all Likert scale questions. Dots close to the outside of the chart indicate a stronger level of agreement than those close to the centre of the chart. The solid red line connects the question means based on the student responses; the dotted navy blue line connects the means based on the mentor responses. Where dots align, this indicates a similar level of agreement between the students and mentors. Where dots are further apart, this indicates a divergence between the two groups.

The five statements with the greatest divergence were 26, 21, 18, 24 and 5 (*Information about tasks was clearly stated; The SHC raised awareness of issues regarding equity and diversity; Learning activities were effective in developing student's understanding; The workload was realistic and appropriate; and The learning materials aided student's learning*). Whilst the means for these statements indicate the greatest difference, the relative ranking across the groups for these statements was very similar. The five statements with the smallest divergence were 9, 14, 13, 15 and 7 (*The learning materials related well to real life situations; The online resources and activities were valuable for student's learning; Overall, I am satisfied with the SHC; There was effective collaboration between group members; and The online resources were of a high quality*).

The ten statements with the highest level of agreement from the student participants are presented in Table 1 in descending order of agreement. A lower numerical mean indicates a higher level of agreement (e.g. a mean of 1 would align with 'Strongly agree' and a mean of 2 would align with 'Agree'). In the top ten statements: four related to the learning content and materials; three related to working in multidisciplinary groups and understanding diverse perspectives; two related to WIL and connecting theory to practice; and one statement related to the SHC challenging thinking.

**Table 1: Student survey responses - ten Likert statements with strongest level of agreement (*Mode responses for each Likert statement are indicated in bold text*)**

| Fig 1 Question key | Likert scale statements | Strongly Agree | Agree | Mildly Agree | Mildly Disagree | Disagree | Strongly Disagree | % positive | Mean |
|---|---|---|---|---|---|---|---|---|---|
| 2 | The SHC improved my ability to appreciate diverse views from other people | **10** | 1 | 0 | 0 | 0 | 0 | 100 | 1.09 |
| 5 | The learning materials aided my learning | **10** | 2 | 0 | 0 | 0 | 0 | 100 | 1.17 |
| 1 | The SHC improved my ability to work in a multi-disciplinary team | **9** | 2 | 0 | 0 | 0 | 0 | 100 | 1.18 |
| 4 | I was able to make a worthwhile contribution to the group project | **8** | 3 | 0 | 0 | 0 | 0 | 100 | 1.27 |
| 6 | The technology used in the SHC aided my learning | **8** | 4 | 0 | 0 | 0 | 0 | 100 | 1.33 |
| 11 | The SHC improved my job-related or work-related knowledge and skills | **7** | 2 | 1 | 0 | 0 | 0 | 100 | 1.40 |
| 8 | The SHC challenged my thinking | **7** | 5 | 0 | 0 | 0 | 0 | 100 | 1.42 |
| 3 | The SHC provided real world examples that helped me to connect theory and practice | **8** | 3 | 1 | 0 | 0 | 0 | 100 | 1.42 |
| 7 | The online resources were of a high quality | **6** | 5 | 0 | 0 | 0 | 0 | 100 | 1.45 |
| 9 | The learning materials in the SHC related well to real life situations | **6** | 4 | 1 | 0 | 0 | 0 | 100 | 1.55 |

The ten statements with the lowest level of agreement from the student participants are presented in Table 2 in ascending order of agreement. The highest mean indicates the lowest level of

agreement. It can be seen from Table 2, that although these are the statements with the lowest level of agreement, the mode responses are all either 'Agree' or 'Strongly agree'. The themes of these statements include: clarity of briefing information; student diversity; workload; and peer learning. There appears to be a level of contradiction between results for some of the statements relating to online learning materials/technology (7, 6 and 23). However, Q23 is the only statement which links the quality of learning materials to student success, and in this instance, students may have perceived not winning the first prize in the Challenge as not having succeeded.

**Table 2: Student survey responses - ten Likert statements with weakest level of agreement**

| Fig 1 Question key | Likert scale statements | Strongly Agree | Agree | Mildly Agree | Mildly Disagree | Disagree | Strongly Disagree | % positive | Mean |
|---|---|---|---|---|---|---|---|---|---|
| 25 | I received timely feedback that was helpful to my learning. | 3 | **4** | 2 | 2 | 1 | 0 | 75 | 2.50 |
| 26 | Information about the SHC tasks was clearly stated | 2 | **5** | 4 | 1 | 0 | 0 | 92 | 2.33 |
| 21 | The SHC raised awareness of issues regarding equity and diversity | **5** | 2 | 1 | 2 | 1 | 0 | 73 | 2.27 |
| 22 | The SHC has a learning environment that takes into account student diversity | **6** | 2 | 1 | 1 | 1 | 0 | 82 | 2.00 |
| 24 | The workload in the SHC was realistic and appropriate | 3 | **7** | 0 | 0 | 1 | 0 | 91 | 2.00 |
| 17 | The content in the SHC was organised in a clear and logical way | 3 | **7** | 2 | 0 | 0 | 0 | 100 | 2.00 |
| 19 | The learning activities in the SHC created opportunities for me to learn from my peers | 2 | **7** | 2 | 0 | 0 | 0 | 100 | 2.00 |
| 23 | The online learning activities helped me to succeed in the SHC | 3 | **6** | 2 | 0 | 0 | 0 | 100 | 1.91 |
| 16 | I understood the requirements and learning outcomes for the SHC | **5** | 4 | 3 | 0 | 0 | 0 | 100 | 1.83 |
| 20 | The SHC improved my ability to apply my knowledge of the UN SDGs | 3 | **7** | 1 | 0 | 0 | 0 | 100 | 1.82 |

## Qualitative survey responses

Both students and mentors were asked seven open-ended questions, including: the most rewarding aspects of the SHC; the most challenging aspects of the SHC; areas for improvement of the Challenge; skills developed and knowledge gained by students as a result of participation; and the benefits and challenges of working in a multidisciplinary team.

When asked about skills and knowledge gained by students, mentors identified the following themes: Technical knowledge; interdisciplinary collaboration; awareness of indigenous perspectives; real-world problem solving; presentation/pitching; and research and idea generation:

> *My mentee's [sic] developed skills in creating real world solutions to a complex and multifaceted problem. This is unique to what is normally presented in their regular studies and required input from multiple disciplines. They also developed skills in presenting and pitching their ideas, equally important for future employment. [Mentor quote]*

Student participants identified the same themes, but additionally identified: critical thinking; time management; and passion for sustainability. The following quote illustrates an individual student's sense of empowerment as a result of these developed skills and knowledge:

> *The challenge has help [sic] solidify my dream to design sustainable homes. I feel like I understand the construction industry a little better [Student quote]*

These skills and knowledges relate closely to the perceived benefits to students of working within a multidisciplinary team. Mentors identified the following benefits: transferable skills; and understanding and accommodating diverse opinions. Student participants identified the same themes, but elaborated on the need to understand both different views and different ways of doing:

> *Sharing and accepting ideas that are not what you are use [sic] to...Sometimes there is more than one right way and you need to compromise and understand/appreciate all the different ways around a problem. [Student quote]*

Students and mentors were also asked to identify the most rewarding aspects of taking part in the Challenge. Both students and mentors identified themes of working in multi-disciplinary teams; real-world problem solving and the valuable resources in the weekly learning modules and discussion sessions.

> *This experience was a small taste of real-world work environments, and I must say it paints an exciting picture. [Student quote]*

Mentors and students were asked what challenges students faced as a result of working in a multidisciplinary team. Many of the challenges identified could be attributed to students working in groups more generally, rather than the multidisciplinary nature of the groups. Other challenges appear to have been exacerbated by the fact that the SHC was impacted by an extended Covid lockdown and restrictions. Mentors identified the following themes: student attrition; inability of some team members to compromise; time required to learn to understand people from diverse backgrounds; and different members starting with differing skills and knowledge base. Students identified the following themes: imposter syndrome; varying levels of commitment; balancing time constraints; and working to accommodate diverse views.

> *Learning another discipline's language takes time [Mentor quote]*

Respondents were also asked how the SHC could be improved in the future. Themes identified by mentors and students included: clarity of the brief/output requirements; more in-person and team-to-team interactions; group mentors; and more industry involvement.

## Student focus group results

An in-person focus group session was held with 9 of the students involved in the SHC 2021. Of the students involved in the focus group, 3 were from an architectural background, 3 were from engineering background and 3 were from other backgrounds.

The following four topics were covered in the focus group:

- Topic 1: Learning environment, recruitment, retention, and attraction for equity & diversity
- Topic 2: Shaping of the final deliverable, outputs and judging criteria.
- Topic 3: Improving interactions with industry and mentors.
- Topic 4: Interdisciplinary communication.

*Topic 1: Learning environment, recruitment, retention, and attraction for equity & diversity*

The discussion highlighted that there was a very positive opinion of working with committed likeminded people. The SHC was perceived to have been able to bring people out of their comfort zone and provide free rein to create innovative solutions. The focus on innovation was seen as a way of cutting through the diversity, as that is an area where anyone can contribute. The initial recruitment process was somewhat targeted, which was perceived to have limited student awareness of the Challenge. Broadening the marketing was suggested as a way to help increase awareness of the Challenge amongst those who could make a strong and committed contribution.

> *I enjoy being able to work with other people from other disciplines… and be given free rein to be able to create. It wasn't, 'This is your assessment task, this is your rubric, try and get HD.' It was, 'See what happens. Here's the internet, here's the world, simply find and see what's going to work'*

### Topic 2: Shaping of the final deliverable, outputs and judging criteria

In terms of the required deliverables and outputs, there was considerable discussion within the focus group around the limited scope in which students could present their work. This was identified as being different from traditional university outputs and restricted what they could showcase. However, one focus group participant identified that this aligns more closely to the real world. There was an appreciation of the need to balance project outputs between scaffolded projects in which the volume of work is easily evidenced, and the real-world constraints of industry.

> *I felt like that wasn't really showcased in the end product because the deliverables didn't demonstrate that kind of background work that we did*

> *That's how the real world works with tenders and that's how the real business world works*

> *…our generation is moving into a sustainable regenerative world. This is what our future looks like. So everyone's kind of like treading into unknown territory and feeling their way around*

### Topic 3: Improving interactions with industry and mentors

The mentorship strategy used in the Challenge required students to identify their own mentor from their discipline. However, this was found to lead to mentors who were not well connected with the Challenge. For students with engaged mentors, it was a very positive and beneficial relationship, but for others, the benefit was limited. It was identified that the Challenge would benefit from greater industry involvement throughout rather than just in the final week.

> *…in terms of industry interactions, I wish we had it throughout.*

> *I think that I understand the benefits of having a mentor but I feel like I don't know how to make the most of that kind of relationship*

### Topic 4: Interdisciplinary communication

Interdisciplinary communication was found to have its challenges, particularly for those from non-engineering backgrounds trying to understand engineering concepts. Participants found the Challenge useful for learning how to communicate clearly with others from different backgrounds, and how to appreciate the views of others. A key finding was that the shared passion for sustainability helped to overcome some of the interdisciplinary teamwork obstacles.

> *It's awesome trying to create an interdisciplinary environment and it's great, cause you can learn so much from everyone and see what they can bring to the table, but trying to get them to stay and find the relevance for themselves, I think might be a bit of a barrier.*

> *The passion that everybody had for sustainability and … the reason they came into this challenge really overcame any issues that arose with not having that shared background.*

## Discussion and conclusion

This evaluation of the SHC, through the perspectives of the student and mentor participants, has highlighted the positive outcomes of the experience, including an affirmation of the significant benefits of learning to work in an interdisciplinary team (Soetanto et al., 2017; Van den Beemt et al., 2020). These benefits include developing an understanding of diverse perspectives and working to reach a common way forward. The success of the interdisciplinary work was facilitated by a shared passion for sustainability amongst the student participants, which enabled them to overcome the obstacles of interdisciplinarity. Whilst the real-world alignment of outputs from the Challenge tested students, the opportunity to learn to work under these conditions in a low-risk context is beneficial and has employability benefits. Opportunities for improving the Challenge lie in increasing industry involvement throughout the process, and revising the mentor strategy to consider industry representatives as mentors, or mentors for the team rather than individuals. Students from all disciplines valued the mixed high quality learning materials. However, non-AEC

students found these to be more time-consuming to comprehend due to their lack of AEC disciplinary knowledge.

Whilst it is acknowledged that the sample group for this research was limited by the number of people involved in the SHC, this evaluation of the experiences of both mentors and students is helpful in establishing the benefits and identifying ways in which this can be improved. Transitioning the SHC to a subject will greatly increase future evaluation sample sizes.

To tackle complex problems, we need diverse teams. It is clear that student participants of this interdisciplinary applied design project experienced benefits in their development of much-needed transferable skills for the workplace, including critical thinking, problem solving and an appreciation of other perspectives. This evaluation provides evidence of the potential benefits of embedding such opportunities within the engineering curriculum.

# References

ACED. (2021). *Engineering Change: The future of engineering education in Australia*. Retrieved from https://www.aced.edu.au/downloads/2021%20Engineering%20Change%20-%20The%20future%20of%20engineering%20education%20in%20Australia.pdf

Adya, M., Temple, B. K., & Hepburn, D. M. (2015). Distant yet near: Promoting interdisciplinary learning in significantly diverse teams through socially responsible projects. *Decision Sciences Journal of Innovative Education, 13*(2), 121-149.

Bunting, A., Carre, A., Kaider, F., Andrews, J., Chapple, B., & Mewburn, I. (2007). *Greenhouse gas reduction in industry: a multidisciplinary approach to project-based learning.'.* Paper presented at the Proceedings of the 18th conference of the Australasian Association for Engineering Education.

Engineers Declare Australia. (No Date). Australian Engineers Declare Climate and Biodiversity Emergency. Retrieved from https://engineersdeclare.org.au/

IPCC. (2022). *Sixth Assessment Report: Fact sheet - Australasia: Climate Change Impacts and Risks*. Retrieved from

Macfarlane, B., & Tomlinson, M. (2017). Critiques of Student Engagement. *Higher Education Policy, 30*(1), 5-21. doi:10.1057/s41307-016-0027-3

Sharma, B., Steward, B., Ong, S., & Miguez, F. (2017). Evaluation of teaching approach and student learning in a multidisciplinary sustainable engineering course. *Journal of cleaner production, 142*, 4032-4040.

Soetanto, R., Childs, M., Poh, P. S., & Glass, J. (2017). Designed to be employed? Measuring the impact of a multidisciplinary collaborative design project on learner perceptions of employability attributes. In *Online Learning for STEM Subjects* (pp. 90-112): Routledge.

Van den Beemt, A., MacLeod, M., Van der Veen, J., Van de Ven, A., van Baalen, S., Klaassen, R., & Boon, M. (2020). Interdisciplinary engineering education: A review of vision, teaching, and support. *Journal of engineering education, 109*(3), 508-555.

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