ŌTAUTAHI CHRISTCHURCH AOTEAROA NEW ZEALAND
35TH AUSTRALASIAN ASSOCIATION FOR ENGINEERING EDUCATION ANNUAL CONFERENCE
8-11 DEC 2024
THE ENGINEER AND THE WORLD

What Style of Tutorial Solution Videos Do Learners Choose to Watch?

Catherine C. R. Sutton [a], David Shallcross [a] and Naomi Bury [a].
The University of Melbourne, Faculty of Engineering and Information Technology
Corresponding Author Email: ccsutton@unimelb.edu.au

ABSTRACT

CONTEXT

Digital teaching and learning resources can be scalable and are required to further develop widespread quality tertiary education, as desired in the UN Sustainable Development Goal 4: Quality Education (specifically Targets 4.3 to 4.5). To enable the development and delivery of helpful teaching videos, we need to understand what makes quality content. Previous studies have found conflicting results regarding which video style is most valuable, and research in the field is ongoing.

PURPOSE

This study seeks to determine which style of videos learners choose to view. Previous work has looked at students' perceptions of and preferences regarding different styles of tutorial video solutions. We seek to investigate whether learner preferences align with learner behaviour. This work will inform decisions regarding the development of tutorial solution videos.

APPROACH

Second-year undergraduate learners are presented with 175 tutorial question solution videos throughout a subject, in conjunction with complete written solutions. The videos are in one of three styles: lecture, voiceover, or handwritten (Khan Academy style). The Kaltura viewing data is analysed to compare learner preference with learner behaviour.

OUTCOMES

Our findings indicate that learners choose to watch Handwritten and Lecture-style videos over Voiceover-style videos. This suggests that learners' video-watching behaviour aligns with student video preferences. Video analytics suggest that students are using videos to set up the tutorial problem or clarify the problem-solving steps rather than for the final solution. Video length was not found to contribute to the learner's choice.

RECOMMENDATIONS

Based on the outcomes of this study, we recommend the production of Handwritten-style videos over Lecture-Style and Voiceover-style videos. Both Handwritten and Lecture-style videos encourage active learning, but Handwritten-style videos require fewer resources for production and are, therefore, more scalable.

KEYWORDS
Engagement, video styles, online teaching and learning.

Introduction

Digital technology presents higher education, including engineering education, with an opportunity to create accessible, scalable educational content to improve students' learning outcomes. Engaging with this opportunity also helps engineering educators contribute to Goal 4 of the UN Sustainable Development Goals: Quality Education (Targets 4.3-4.5). Of the three teaching approaches used for online videos (Kay, 2012), this research is focused on problem-solving videos. Problem-solving videos have been used in engineering for over a decade (Ventura-Medina, 2012) and continue to be used in multiple engineering disciplines (Dart, 2020; Dart, Cunningham-Nelson, et al., 2020; Dart, Pickering, et al., 2020; Sutton et al., 2023).

Previous research has found that problem-solving videos (also called tutorial solution videos or worked example videos) encourage students to engage with active learning (Barns et al., 2017; Dart, Cunningham-Nelson, et al., 2020; Dart, Pickering, et al., 2020; Fyfield et al., 2019), which leads to better learning outcomes (Freeman et al., 2014). Across different studies, students consistently report that they appreciate the explicit description of the problem-solving steps and why they are used (Dart, Cunningham-Nelson, et al., 2020; Dart, Pickering, et al., 2020; Ventura-Medina, 2012). These descriptive steps provide extra scaffolding to students that is often missing from written tutorial solutions. Students also report using these videos for clarifying conceptual understanding, support for assessment, and replacing/ supplementing missed classes (Barns et al., 2017; Dart, Pickering, et al., 2020; Sutton et al., 2023). These tutorial solution videos can be presented in at least three ways: lecture-style, voiceover-style or handwritten-style (often called "Khan Academy-style", Sutton et al., 2023), but most studies have only examined handwritten-style tutorial solution videos. Sutton et al. (2023) found that students preferred lecture-style and handwritten-style over voiceover-style, but concluded that further research was needed to understand which style students used more.

Research Questions

In this study, we aim to compare students' self-reported video preferences with video analytics to determine which style of tutorial solutions video was preferred overall by students. This study aims to inform decisions regarding developing tutorial solution videos in the most time- and resource-effective manner. To do this, we aim to answer the following research questions:

1. Do students' tutorial solution video preferences align with their viewing behaviour?
2. Which style of tutorial solution video do students choose to watch?

Method

Context and Intervention

This study is situated in the context of CHEN20010 Material and Energy Balances, an undergraduate chemical engineering subject at the University of Melbourne. It is one of the first chemical engineering subjects that students take in the degree. Tutorial workshops centre the weekly problem sets students complete in the tutorials. The final numerical solutions are available during tutorials, and at the end of the week, complete, written, and worked solutions are available to students for all problems. Additionally, tutorial solution videos are available for many problems at the end of the week.

A total of 175 tutorial solution videos were provided in one of three styles: **Lecturer style** (the presenter is visible in front of typed slides), **Voiceover style** (only the typed slides are visible), and **Handwritten style** (the solutions are handwritten written onto a tablet; also known as Khan Academy style). Each video solves a single tutorial problem, including the problem-solving steps for each section of the problem, which is one of the main reasons students use tutorial solution videos (Dart, Pickering, et al., 2020). There are 44 Lecture style videos, 68 Voiceover style videos and 63 Handwritten style videos.

 Copyright © Catherine C. R. Sutton, David Shallcross and Naomi Bury, 2024

Only one style of tutorial video was available for problems on early tutorial sheets. For some problems in later tutorial sheets, two or even all three kinds of videos were available, so students could choose which type of videos they wanted to watch. Note that where multiple solutions are available for the same problem the ***substance*** of the solution was the same in all videos, and so we are able to compare preference of the ***style***. The second author, an experienced engineering lecturer and engineering education researcher, developed all the videos. Use of the same presenter for all videos ensures (for this study) that students are not choosing between presenters, which avoids considerations of bias to different presenters.

All videos require the same thought, care, and pre-production preparation, which are often the most important factors in creating high-quality videos that students engage with (Guo et al., 2014). Beyond that, the Lecturer and Voiceover styles require the preparation of PowerPoint slides, while the Handwritten style requires a tablet or computer with a writable screen. All require a professional-quality microphone and editing software. The Lecturer style is the most resource-intensive, requiring a green screen and camera.

Data Collection and Analysis

Videos were hosted by Kaltura Media and embedded in the Canvas Learning Management System. For each video, the following analytics were manually extracted: Player Impressions, Number of Plays, Number of Unique Views, Total Minutes Viewed, and Average Completion Rate (number of minutes viewed as a percentage of total length of the video). Player impressions included students who opened the video page but did not watch it, so this measure was not used in the data analysis. The total Minutes Viewed for each video depends on how long each video was, with some videos being as short as 1 minute 19 seconds and others being over 30 minutes. This makes a direct comparison between videos difficult. Therefore, the Average Completion Rate was used to measure how much of the video students watched instead.

These videos have been used for four years, and all four years of aggregated data were used for this study. All data was aggregated and could not be traced back to individual students. This study has University Ethics approval, Project ID Number 2023-22881-42409-4.

Averages for each viewing measure (plays, unique views, completion rate) were taken for each style of video and averaged over all the videos. Where multiple video styles were available for a single tutorial question, video analytics were compared to see which video style was viewed more by students. This data is presented as averages of the metrics for each style, furthermore, the ratio of each metric calculated for each problem, and the average of the ratios presented.

Results and Discussion

All Videos: Initial Analysis

The results were mixed when comparing the average viewing measures of all three video types, as seen in Table 1. The voiceover style has the highest average plays and unique views, while the lecture and handwritten style videos had higher completion rates (48.5% and 46.2%, respectively, vs. 40.7%). As shown in Figure 1, the average completion rate for all three styles is generally 40-60 % when broken down by weekly Exercise Sheet, and we note that no Style is higher or lower than the others. As shown in Figure 2, when broken down by Exercise Sheet, the Average Number of Plays per video ranges from five to almost 50, and no trends were observed either by Style or across the course of the semester content.

To investigate the effect of video length on viewing preferences, the Average Completion Rate of each video is plotted against the Video Length in Figure 3. There is no strong trend. It can be said that only videos less than three minutes have an Average Completion Rate of more than 80%, however, most videos of this length have much lower ACRs. Similarly, we can say that no video longer than 10 minutes has an ACR higher than 60%, and while this is not surprising, it is not overly insightful.

 Copyright © Catherine C. R. Sutton, David Shallcross and Naomi Bury, 2024

Table 1: Average viewing measures for all videos and each style: Lecture, Voiceover and Handwritten

	All Videos	Lecture	Voiceover	Handwritten
Average Plays	21.2	17.7	24.7	20.1
Average Unique Views	18.2	15.6	21.0	17.3
Average Completion Rate	44.7%	48.5%	40.7%	46.2%

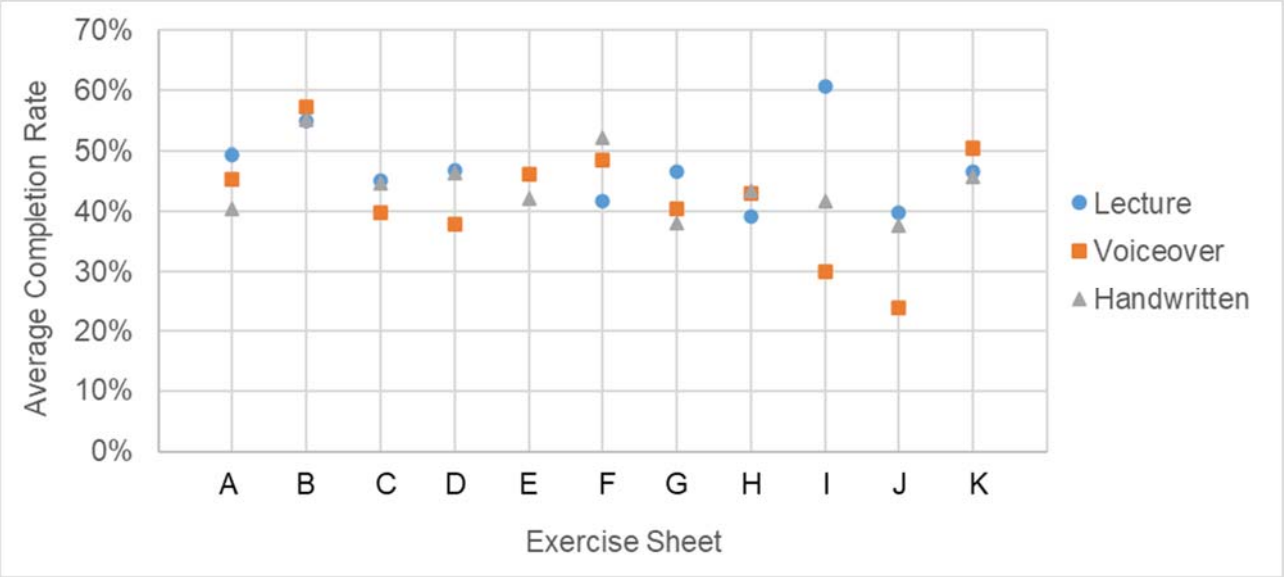

Figure 1: Average Completion Rate of videos in each Exercise Sheet, broken down by the styles of Lecture, Voiceover and Handwritten

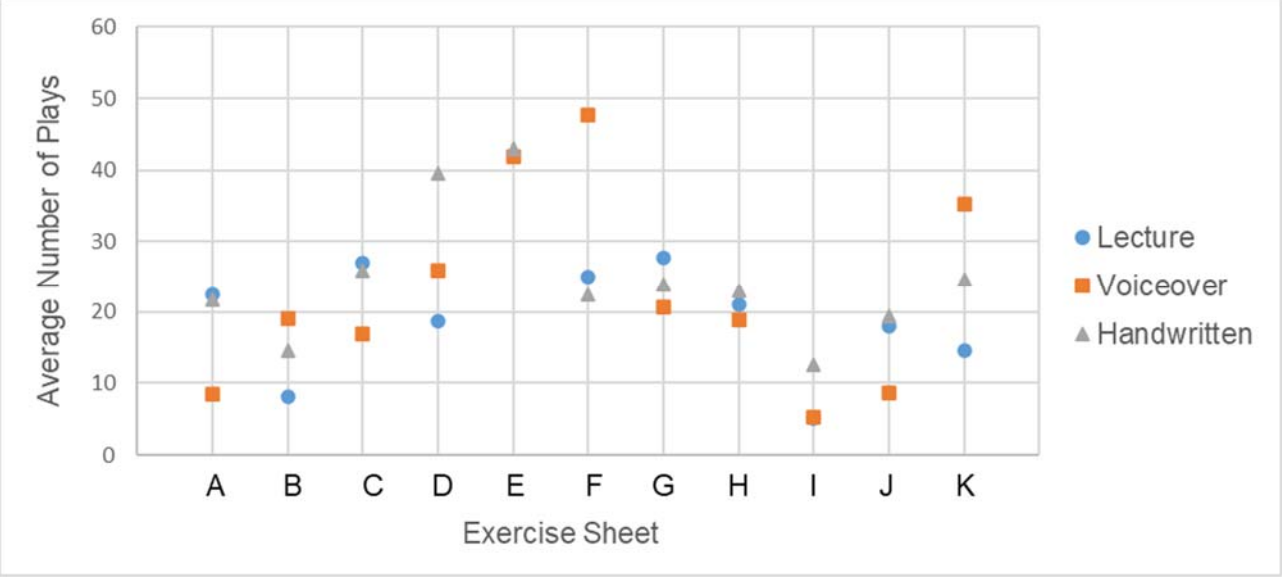

Figure 2: Average Number of Plays of videos in each Exercise Sheet, broken down by the styles of Lecture, Voiceover and Handwritten

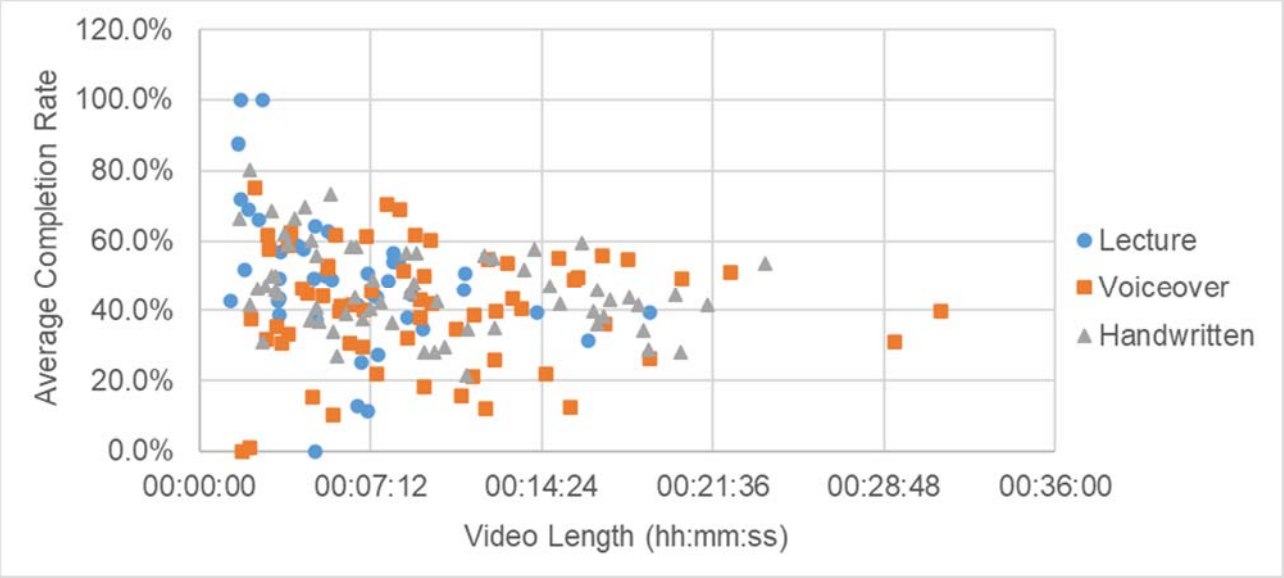

Figure 3: Average Completion Rate of videos plotted against the Video Length, broken down by the styles of Lecture, Voiceover and Handwritten

Video Solutions Available in More Than One Style: Student Choice

It is likely that the specific tutorial problem solution itself also influences which video is watched, so a direct comparison between types of videos for the same tutorial problem solution is helpful to tease out this relationship further. There are 16 problems for which solutions are available in two styles and five problems for which the solutions are available in all three styles. While this is not a large sample size, these direct comparisons can provide insight into student viewing choices.

Table 2 presents the Average viewing measures for cases where two Styles of videos were available for each Problem Solution. Note that in addition to the metrics for each Style, we also looked at the ratio of the metrics for each video and additionally presented the average of those ratios. When comparing Lecture and Voiceover styles, the ***Lecture style had a higher completion rate, number of plays, and unique views***. Lecture-style videos received a higher number of Plays in all but one case and, on average, received around three times as many Plays as Voiceovers, as shown by the L/V Ratios. We note that the length of these videos does not appear to have played a part in student choice, as the Lecture style was longer than the Handwritten style in almost half of the cases. When comparing Handwritten and Voiceover styles, the ***Handwritten style has more plays, unique views and completion rate***. Comparing lecture and handwritten styles was difficult, as there were only two solutions with both video styles. The Lecture style has a slightly higher completion rate, while the Handwritten style has higher plays and unique views. Looking at the H/L Ratios, the ***Handwritten style received twice as many Plays as Lecture style videos***. We also note that in ***all cases*** that included a Handwritten style, the Handwritten style video was the ***longer video***.

Table 2: Average viewing measures for cases where two Styles of videos were available for each Problem Solution

	Lecture and Voiceover			Handwritten and Voiceover			Handwritten and Lecture		
Number of Problem Solutions	9			5			2		
	L	**V**	**L/V Ratio**	**H**	**V**	**H/V Ratio**	**H**	**L**	**H/L Ratio**
Average Plays	21.6	9.1	2.9	12.8	9.2	1.7	25.0	12.5	2.2
Average Unique Views	18.7	8.3	2.7	11.0	8.6	1.5	19.0	10.5	1.9
Average Completion Rate	43.6%	34.9%	1.79	43.8%	31.4%	1.84	35.8%	41.1%	0.97

Table 3 shows the Average viewing measures for cases where all three Styles of videos were available for each Problem Solution. The lecture style had the highest completion rate, while the Handwritten style had the highest plays and unique views. From the data, the Handwritten and Lecture styles were watched in preference over the Voiceover style. In all cases, the Handwritten style received more Plays than the others. We also note that in ***all cases***, the length of the Handwritten style video was ***longer*** than either the Lecture or Voiceover styles; students are not just choosing to watch the shortest video.

Table 3: Average viewing measures for cases where all three Styles of videos were available for each Problem Solution

	Lecture	**Voiceover**	**Handwritten**	**H/L Ratio**	**H/V Ratio**
Average Plays	1.6	1.2	9.6	7.8	7.1
Average Unique Views	1.4	1.2	9.2	7.8	6.8
Average Completion Rate	65.2%	23.3%	41.3%	0.58	8.88

While this study has a small sample size, we can conclude that students choose to watch Lecture-style and Handwritten-style tutorial solution videos over Voiceover style. This is consistent with the student preference data from the qualitative survey data published by Sutton et al. (2023), which suggests that student watching behaviour is consistent with student watching preferences. Both Lecture-style and Handwritten-style video styles encourage active learning in

students, and active learning often leads to better educational outcomes, suggesting that both Handwritten- and Lecture-style videos may lead to better educational outcomes for students.

Handwritten style videos often require significantly less resources (e.g., educator time, funding, equipment) than lecture-style videos. This suggest that handwritten style videos are a better use of limited education resources, and may still lead to good educational outcomes for students, based on the principle of active learning.

Further Considerations

Another reason to focus on producing handwritten-style videos over lecture-style videos is that these tutorial solution videos are supplementary material: they supplement the lectures. And the content delivery in lectures is very similar to the “lecture style” videos. So, if students prefer Lecture-style videos to handwritten ones, the lectures and their recordings are already available. Noting that about 300 students have been in the course over the four years of this study, an average Number of Plays between 17 and 25 seems a small number overall. However, as these are supplementary videos, not core videos, we don’t expect them to have high views. These videos are still valuable. Even if not every student in the subject watches them, they still provide valuable learning experiences.

Investigating which videos students use most often is a useful indication of where further discussion is needed in class. For example, the video for question F7 had 93 plays and was watched for 1067 minutes. The average number of plays for that tutorial sheet was 64.8, and the average number of minutes viewed was 435.9. Question 7’s figures were well above the average for the tutorial sheet, indicating that students struggled with this tutorial question and needed to watch the video multiple times to understand the solution. Turning this tutorial question (or one similar) into a worked example in a lecture might be a helpful way of guiding students.

The average completion rate for all 175 videos is 44.7%, which implies that most students are not watching the video through to the final solution of the question. This is consistent with the third author’s experience as a tutor in the subject, where students struggle to begin a question but can work through the problem more easily once it has been set up. This is also consistent with the literature that describes the primary use of tutorial solution videos to understand the problem-solving steps in the question. This is likely especially true for students early in their engineering education, such as those in this subject, as they require more scaffolding before starting work than students later in their engineering education. Further research, such as focus groups or qualitative surveys, is needed to understand this behaviour fully.

Conclusion

Based on the video analytics of 175 tutorial problem solution videos, this study has found that students’ solution video preferences align with their viewing behaviour. The study found that ***Lecture style and Handwritten style videos are viewed over Voiceover style***, which aligns with students’ preferences for Lecture style and Handwritten style videos reported by Sutton et al. (2023). The authors found some evidence that students chose to view videos in the ***Handwritten style in preference to that of the Lecture style***. It was found that the ***Style*** of video had a greater impact on student choice that the ***length*** of video; ***students did not just choose to watch the shorter video***. Lecture-style and Handwritten-style videos encourage active learning, which may lead to better educational outcomes. Handwritten-style videos require fewer resources to produce. When considering all factors, including efficient use of resources, we recommend producing future videos in the Handwritten style.

Further research should examine why students, on average, watch less than half of the video and whether videos with the most views cover content that students need clarification on. By creating scalable, accessible educational content, such as these tutorial solution videos, for engineering students, we are contributing to improving educational outcomes for our students and to better higher education, part of the UN SDG 4 (Targets 4.3-4.5).

 Copyright © Catherine C. R. Sutton, David Shallcross and Naomi Bury, 2024

References

Barns, S., Pickering, E., & Dawes, L. (2017). *Worked Example Videos as a Valuable Blending Learning Resource in Undergraduate Engineering Units*. Australasian Association of Engineering Education Annual Conference, Sydney, NSW, Australia.

Dart, S. (2020). *Khan-Style Video Engagement in Undergraduate Engineering: Influence of Video Duration, Content Type and Course*.

Dart, S., Cunningham-Nelson, S., & Dawes, L. (2020). Understanding student perceptions of worked example videos through the technology acceptance model. *Computer Applications in Engineering Education*, *28*(5), 1278–1290. https://doi.org/10.1002/cae.22301

Dart, S., Pickering, E., & Dawes, L. (2020). Worked Example Videos for Blended Learning in Undergraduate Engineering. *AEE Journal*, *8*(2), 36021. https://doi.org/10.18260/3-1-1153-36021

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences*, *111*(23), 8410–8415. https://doi.org/10.1073/pnas.1319030111

Fyfield, M., Henderson, M., Heinrich, E., & Redmond, P. (2019). Videos in higher education: Making the most of a good thing. *Australasian Journal of Educational Technology*, *35*(5), 1–7. https://doi.org/10.14742/ajet.5930

Guo, P. J., Kim, J., & Rubin, R. (2014). How video production affects student engagement: An empirical study of MOOC videos. *Proceedings of the First ACM Conference on Learning @ Scale Conference*, 41–50. https://doi.org/10.1145/2556325.2566239

Kay, R. H. (2012). Exploring the use of video podcasts in education: A comprehensive review of the literature. *Computers in Human Behavior*, *28*(3), 820–831. https://doi.org/10.1016/j.chb.2012.01.011

Sutton, C. C. R., Shallcross, D., & Pearson, A. (2023). *What Style of Tutorial Solution Video Should We Make?* Australasian Association of Engineering Education Annual Conference, Gold Coast, Queensland, Australia.

Ventura-Medina, E. (2012). *Using Podcasts to demonstrate the use of graphical/numerical techniques in Chemical Engineering*.

Acknowledgements

The authors would like to acknowledge the Faculty of Engineering and Information Technology (FEIT) and the FEIT Teaching & Learning Laboratory at the University of Melbourne, for providing the “Education Travel Support” funding that allowed the first author to attend and present at this conference.

Copyright statement

Copyright © Catherine C. R. Sutton, David Shallcross and Naomi Bury, 2024. The authors assign to the Australasian Association for Engineering Education (AAEE) and educational non-profit institutions a non-exclusive licence to use this document for personal use and in courses of instruction provided that the article is used in full and this copyright statement is reproduced. The authors also grant a non-exclusive licence to AAEE to publish this document in full on the World Wide Web (prime sites and mirrors), on Memory Sticks, and in printed form within the AAEE 2024 proceedings. Any other usage is prohibited without the express permission of the authors.