

2023

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Recommended Citation

Buskes, G., & Chan, H. Y. (2023). Returning To On-Campus Activities For First-Year Engineering Skills Development - A Comparative Study. European Society for Engineering Education (SEFI). DOI: 10.21427/1XJP-6T22

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Returning to on-campus activities for first-year engineering skills development - a comparative study

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Conference Key Areas: *Engineering Skills and Competences. Curriculum Development*

Keywords: *Skills development, first-year, project-based, on-campus*

ABSTRACT

Prior work by the authors on student skills development detailed the implementation of a suite of skills modules in a first-year engineering course. These modules were instrumental components in supporting the course's project-based framework that offered flexibility of choice and timing in a low-risk setting. It was found that, while receiving overall favourable student feedback, most students only completed the minimum requirements and largely chose technical modules according to the relevance to their project topic.

Due to the cessation of on-campus teaching activities caused by the COVID-19 pandemic, these modules were delivered wholly online. With the lifting of restrictions the following year, the modules were made available with several distinctions: (a) the option of completing wholly online or a mix of online and on-campus activities; and (b) a change to a graded assessment scheme to encourage students to put more effort into their completion.

An evaluation performed on the modules revealed that online-only modules were attended at a rate comparable to on-campus activities. The distribution of module completions over the semester was influenced by module availability, students' time management and module alignment with their project. A higher concentration of module completions occurring closer to deadlines indicated that students were more time pressed and completed the modules just in time. A change to the grading scheme did not appear to affect the take up rates of the modules but did result in better quality of work. Students still elected to complete modules aligned with their project, consistent with previous trends.

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1 INTRODUCTION

As a result of emerging from the COVID-19 pandemic, many universities that saw transitions from face-to-face to online learning during the peak of the pandemic are now having to transition back to traditional, on-campus delivery modes. During this transition, universities have adopted many different models of simultaneously supporting both online and on-campus students (Almendingen et al. 2021; Hur 2022). Hybrid styles of delivery, such as those combining online and on-campus students in design studio environments, often used in engineering, have raised issues of learner equity and access, cohort building, and negative staff and student perceptions (Thompson et al. 2021). ‘Split cohort’, or ‘dual delivery’, where online and on-campus students are treated as separate cohorts within a course and have distinct teaching streams (and possibly assessment tasks), can mitigate some of these issues, however there are still negative perceptions of such an approach, in terms of lack of face-to-face interaction with instructors and lack of support for online students (Kember, Trimble, and Fan 2022; Glazier and Harris 2021). These models typically assume that students able to attend on-campus activities must necessarily attend them, while online students are only able to attend activities in an online capacity. What is unclear, however, is what students’ preferences are when given the opportunity to *choose* between attending on-campus or online activities and whether this affects patterns of attendance, completion rates, scheduling, engagement and academic performance compared to when offered only as wholly online activities.

This paper describes how a suite of skills modules, initially introduced as online-only activities in a first-year engineering course during the peak of the COVID-19 pandemic, were adapted for a return to campus, permitting students the option to complete wholly online or as a combination of online and on-campus activities. These modules covered both technical (related to the specific design project) and general (i.e. professional) skills. Differences in patterns of behaviour between online and on-campus students across these two categories were investigated. Comparisons in student completion rates and timeliness to the wholly online mode of the skills modules that was implemented the prior year are also presented and discussed.

2 BACKGROUND

Prior work by the authors on student skills development detailed the implementation of a suite of skills modules in a first-year engineering course, Engineering Modelling and Design, at the University of Melbourne (Buskes and Chan 2022). These modules were instrumental components in supporting the course’s project-based framework, where students work on a semester-long project such as programming an autonomous robot, designing, building and testing a speaker, or simulating and mitigating the effects of a coastal flooding event. The suite consisted of four *general* skills modules – Teamwork, Report Writing, Video Production and Prototyping, designed to develop the professional skills deemed necessary for completing each

project and six *technical* skills modules, developed to cover a range of discipline skills in engineering that closely aligned with the projects, namely Basic MATLAB/Simulink, Simulink Stateflow Robot Control, Circuit Theory and Analysis, Arduino, CAD & 3D Printing and QGIS. As part of the course assessment, students were required to complete at least one General skills module and at least one Technical skills module to qualify for 10% of the course mark.

The three general skills modules - Report Writing, Video Production and Prototyping were offered as self-paced, online modules developed in H5P, comprising guided activities that built towards the submission of a piece of assessment.

The six technical modules and the general Teamwork module were each originally designed as self-enrolled on-campus workshop-based sessions, where a demonstrator would facilitate a series of activities derived from the intended learning objective(s) of the particular module. During the 1.5hr facilitated workshop sessions, students would first progress through a set of guided activities and then be required to individually complete a set of specific tasks in order to be certified as having completed the module. In Semester 2 of 2021, when the skills modules were first introduced, these workshops were conducted wholly online due to COVID-19 restrictions and a pass mark was automatically awarded if a student attended the workshop and attempted the tasks, without consideration if all tasks were successfully completed.

3 CHANGES TO WORKSHOP-BASED SKILLS MODULES

With the transition back to face-to-face learning in Semester 2 of 2022, more than 90% of the students in the course reported being able to attend classes on campus. While the three general skills modules, Report Writing, Video Production and Prototyping, continued to be offered as self-paced, online modules in H5P, the workshop-based skills modules, namely the six technical modules and the general Teamwork module, had to be adapted to accommodate both online and on-campus students in the cohort. The implementation of such a hybrid delivery model provided students with flexibility in completing the workshop-based modules – the choice to either complete the modules entirely online (online preparation and online workshop session) or opt for a combination of online (online preparation) and on-campus workshop session as shown in Table 1. While the online mode of delivery was only available for those students who were unable to attend campus, both options were available to students who were able to attend campus.

Across the 12-week semester, an average of one out of four workshops were delivered online, distributed in a way that each skills module included at least one online workshop to accommodate the online students. QGIS remained the only skills module with wholly online workshops in line with the coastal flooding project which was offered as a simulation-based, online-only project.

Table 1. Delivery modes of skills modules (indicated by 'X')

Module Type	Module	Mode of Delivery		
		Self-paced Online	Workshop-based	
			Workshop Preparation (Online)	Workshop Session (Online / On-campus)
General	Teamwork	N/A	X	X
	Report Writing	X	N/A	N/A
	Video Production	X	N/A	N/A
	Prototyping	X	N/A	N/A
Technical	Basic MATLAB/Simulink	N/A	X	X
	Simulink Stateflow Robot Control	N/A	X	X
	Circuit Theory and Analysis	N/A	X	X
	Arduino	N/A	X	X
	CAD & 3D Printing	N/A	X	X
	QGIS	X	N/A	N/A

In the revised workshop structure, the workshop sessions maintained their 1.5hr duration, however the previous policy of an automatic pass mark for attendance and participation was replaced with a scaffolded assessment structure. Under the new structure, students were awarded a weighted mark for each of the multiple tasks they completed within the workshop session. This was implemented across both online and on-campus workshops as motivation for students to complete all the tasks to fulfil a particular skills module's intended learning outcome(s).

4 EVALUATION AND DISCUSSION

In Semester 2 of 2022, the multiple delivery modes for the skills modules were offered to a hybrid cohort of 344 students, of which 25 were online-only students who were unable to attend any classes on campus. A comparative analysis was conducted to observe module completion trends between the wholly online cohort of 2021 versus the hybrid delivery cohort of 2022, where students had the option to attend the workshop sessions either on-campus or online.

4.1 Completion rate of skills modules

A comparison of the completion rates of the skills modules between 2021 (wholly online) and 2022 (hybrid) cohorts is shown in Table 2, where the 2022 hybrid cohort is further broken down into students who indicated they were not able to attend campus and those who indicated they were able to (but could chose not to).

Table 2. Completion rate of skills modules

Cohort	% who completed at least one module	
	General module	Technical module
Wholly online cohort in 2021	81.0%	86.7%
Hybrid cohort in 2022	88.9%	89.0%
- Students unable to attend campus	84.0%	56.0%
- Students able to attend campus	90.3%	91.5%

There was a slightly higher overall completion rate of both types of module in 2022 compared to 2021, however, when examining the breakdown of the 2022 data, it was observed that the completion rate for the Technical modules among students unable to attend campus was significantly lower at 56%. This contrasts to the on-campus students who achieved a much higher completion rate of 91.5%.

This discrepancy could be attributed to several factors. Firstly, on-campus students were familiar with the learning spaces hosting the on-campus workshop sessions and could conveniently attend the Technical module workshops after one of their other classes. Additionally, on-campus students had a broader range of workshop session times to choose from due to expected demand and thus had more options and flexibility in scheduling their workshop sessions.

In contrast, online students were perhaps disadvantaged by the limited number of online workshops offered during the semester, with only one online workshop session available for most technical modules. Motivation also likely played a role in the lower completion rate among online students. Unlike on-campus students, online students lacked the opportunity for face-to-face interaction with peers. As a result, they may have missed out on an element of peer encouragement and motivation, which can often be influential in completing workshop assessments.

The overall cohort completion rate for the Technical module of over 86% remained largely consistent from 2021 to 2022. This suggests that the introduction of task-based assessment components into the Technical workshop sessions did not affect the completion rate. In fact, informal discussions with students and demonstrators revealed that students were more motivated to complete all the tasks in the workshop, indicating that the assessment tasks served their purpose in facilitating student learning and ensuring that all learning objectives were fulfilled.

Further analysis of the 2022 cohort's completion of different combinations of the general and technical skills modules unveiled that a majority of students, comprising 85% of the cohort, completed only the minimum requirement (of one General and one Technical module) to achieve the skills module mark - a similar trend to the 2021 cohort. However, there was a slight increase of 1.5% in the number of students who completed more than the minimum requirement in 2022 compared to the previous year. The majority of students focused on meeting the minimum requirements, suggesting that the cohort generally aimed to fulfil only the necessary criteria to obtain the skills module mark. While some students demonstrated an inclination to

go beyond the minimum, the overall completion pattern remained consistent with the previous year's cohort.

4.2 Uptake of skills modules workshop sessions

An evaluation of weekly workshop session subscriptions revealed that among the on-campus students, approximately 80% completed their workshop-based skills modules in the on-campus workshops, while the remaining 20% completed them online. Figure 1 shows the average percentage of subscriptions to on-campus and online skills modules workshops in 2022, computed from the ratio of the number of attendees to the workshop capacity limit. Based on the orange and blue bar-pairs in Figure 1, the average subscription rates between the on-campus and online workshops were surprisingly comparable, with a few exceptions - the Arduino module recorded zero subscriptions to the online workshop and the QGIS modules were exclusively offered online.

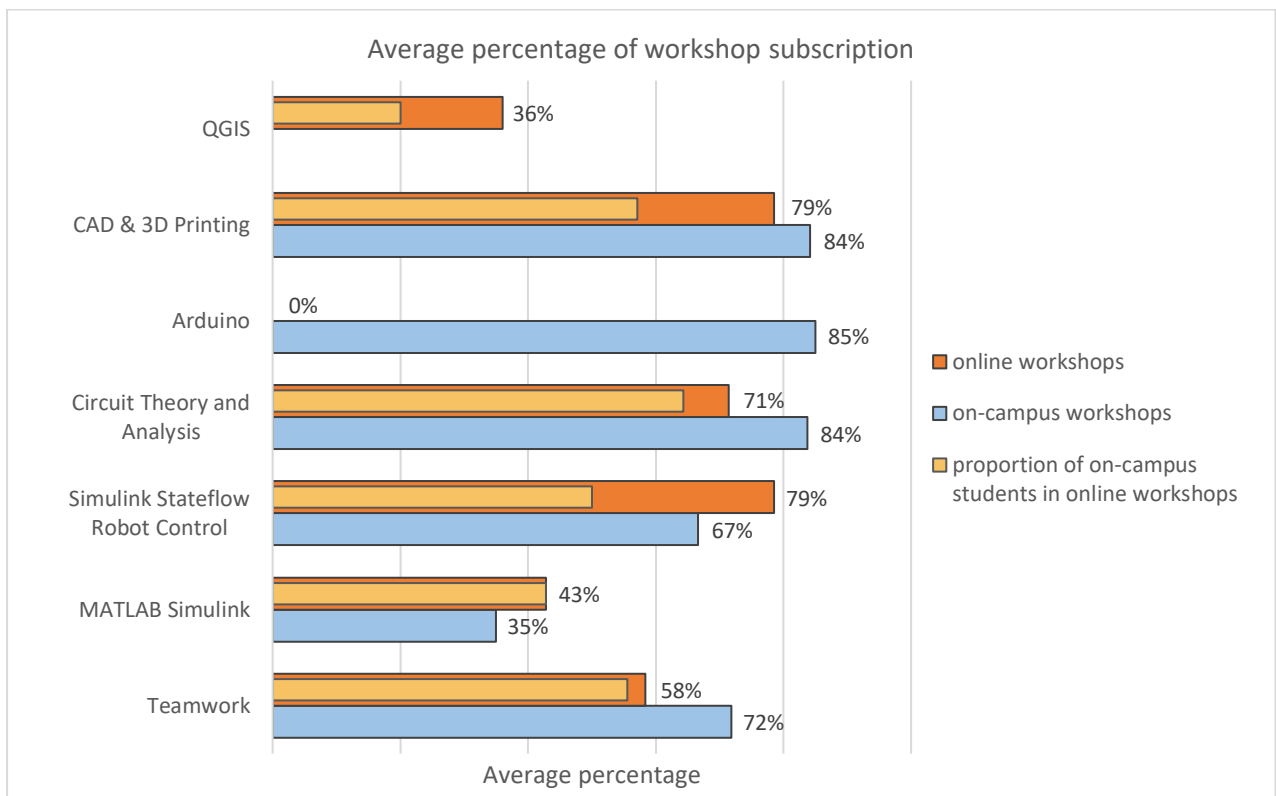


Fig. 1. Average percentage of workshop subscription in 2022

Within the online technical workshops, on average approximately 70% of attendees were on-campus students who chose to complete their modules online, represented by the yellow bars within the orange in Figure 1. It is worth noting that two outliers were not included in the observation: (1) 100% of the MATLAB/Simulink online workshop attendees were from the on-campus cohort, while (2) the online Arduino workshop had zero attendees, indicating a clear preference for on-campus attendance for this specific module. Significant on-campus student subscription to certain online workshops such as those involving Simulink and CAD, suggests that students were not opposed to attending online sessions for modules that had heavier

emphasis on computer-based activities. On the other hand, students preferred the on-campus workshop for the Arduino module, which entailed programming hardware as opposed to simulation.

The online general Teamwork module subscription was dominated by on-campus students at the rate of 95%, mainly because the last Teamwork workshop was offered online at the end of semester and students had no alternative if they wanted to complete the module as part of the General module requirement.

In terms of subscription rates, the MATLAB/Simulink module did not attract as high an interest as the other modules, partly because this module was offered towards the first half of semester to provide basic knowledge in Simulink. Students in the Autonomous Robot project stream likely found that there was no longer a need to attend this basic module past Week 3 once they were well underway in their project. The QGIS workshops, offered fully online, were also poorly subscribed due to the very specific nature of the module only associated with the Coastal Flooding project and the small number of students in that project stream.

4.3 Timeline of skills modules completion

The completion of technical skills modules largely aligned with the particular projects, reaffirming the observations from the 2021 cohort (Buskes and Chan 2022). There was no discernible trend for when students chose to complete the modules with workshop components (i.e. the Teamwork and the technical modules) as uptake was reasonably distributed over the semester weeks, depicted by the solid blue coloured columns in Figure 2.

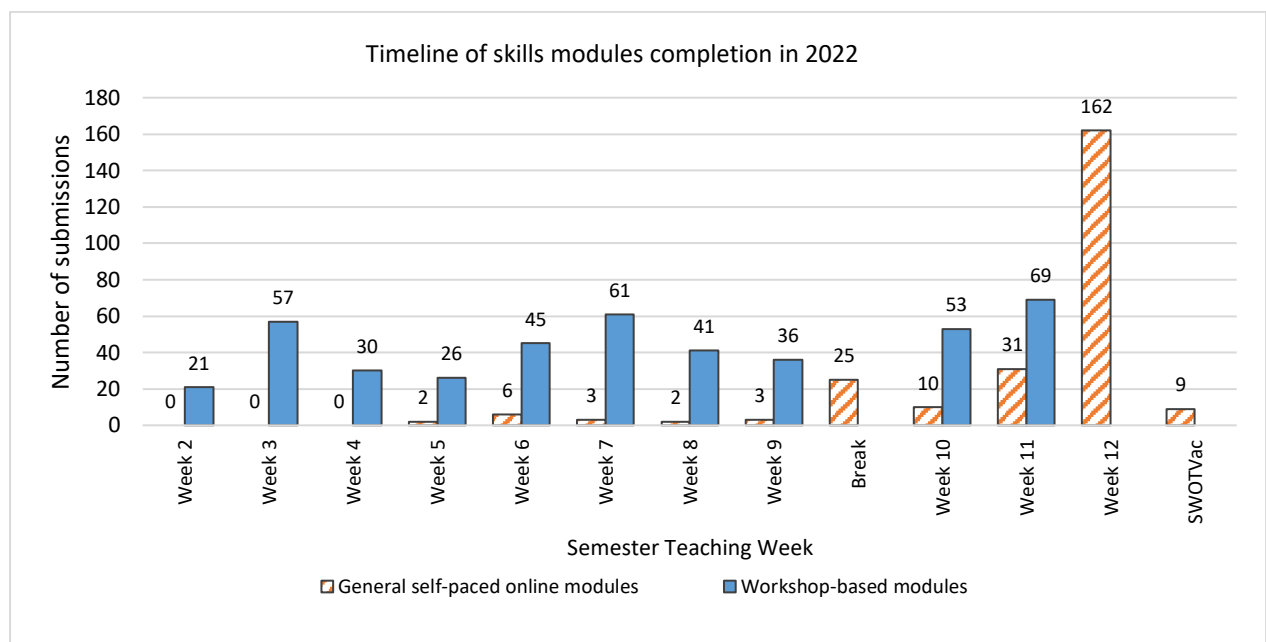


Fig. 2. Timeline of skills modules completion in 2022 (hybrid)

The general trend in 2022 was that higher module uptake occurred in weeks when more workshops were offered, suggesting that students tend to take up the technical modules at their convenience aligned with the availability of workshops. The peak in

Week 11 was likely the result of students rushing to fulfil the minimum skills module completion requirement before the workshops ceased.

There was a notable lack of completion of the general online self-paced modules throughout the semester until around Week 11, as shown by the orange patterned columns in Figure 2. A sudden surge in submission numbers occurred in the final week of the 2022 semester, which was the deadline for the general skills modules. The observation suggests that students from the 2022 cohort tended to prioritise completing modules with a workshop component first, as there are limitations to workshop offerings and availability. As a result, online self-paced modules were left to the end of semester when students were likely pressed for time. In 2021, the spread across semester was broader and not as concentrated in Week 12, which could be attributed to the additional flexibility that students had with wholly online learning and that they had more available time to spare by not having to travel into the campus during lockdown conditions.

5 CONCLUSION

With a hybrid cohort in 2022, the high completion rate of the workshop-based skills modules among on-campus students contrasted with the low rate among online students, suggesting that self-motivated enrolment into workshops is more effective when there is campus interaction among students. This is encouraging for future offerings of the course, with all university degree programs moving back to fully on-campus cohorts over the next year. With two delivery modes of workshops offered, on-campus students were not opposed to the option of online workshops for modules that are mainly computer-based, but preferred to do them on-campus if there was a hardware element involved. It was encouraging that the introduction of an assessment component in the workshops provided motivation to complete all workshop tasks and did not deter students from attempting or completing the modules. From the outcomes of the study, two areas for future improvements were identified: (1) planning of workshop offerings in future should be reviewed to avoid having too many undersubscribed workshops; and (2) considering offering an incentive to encourage earlier completion of the self-paced online general modules to bridge the significant gap between the completion time of the general and technical modules across the semester.

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