34th Australasian Association for Engineering Education Conference
3 - 6 December 2023 – Gold Coast, QLD

Informal learning spaces to enhance engagement, belonging and engineering identity in first-year students

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ABSTRACT

CONTEXT

Informal learning spaces (ILS) are essential to facilitate active and collaborative learning outside scheduled classes. ILS can provide access to specialised equipment and expert guidance to explore and consolidate theoretical and practical concepts. They enable students to engage in hands-on learning at their own pace, complementing their formal classroom education. This study examines the effect of providing a dedicated ILS in a post-COVID environment for first-year engineering students, the First Year Learning Centre (FYLC).

PURPOSE OR GOAL

The purpose of this study is to evaluate the effectiveness of the FYLC in terms of its affordances as an informal learning space, as well as its impact on engagement, identity and belonging. A pilot of the FYLC was launched in Semester 1, 2023. The dedicated room features team-based seating, laptop charging, a whiteboard, 3D printers, electrical testing equipment, and free Milo™. Engineering faculty Makerspace staff, who are current students with design and equipment expertise nearing the completion of their degrees, serve as 'near-peer' mentors. Subject-specific drop-in help desks were also conducted by teaching staff to assist with theory and projects.

METHODOLOGY/METHODS

The FYLC was evaluated through an anonymous survey sent to all students enrolled in a level 1 engineering subject at the Monash University Clayton campus. In addition to seeking general feedback on the FYLC, the survey includes questions designed to explore student belonging through a number of target domains, including competencies, motivations and perceptions of belonging. Students were invited to a pilot focus group, to explore the themes discovered in the survey responses.

OUTCOMES

The FYLC space was well utilised, with the room overflowing in the lead-up to major assessments. The benefits to students of using the space included enhanced collaboration and more access to specialist equipment outside class time to work on projects. No significant differences in identity or belonging were found between students who used the FYLC and those who did not - however, differences in engineering identity, perceptions of subject competence and social interactions were found between men and women.

CONCLUSIONS

The FYLC was highly valued by students and received positive feedback. The space will be expanded in Semester 2, 2023. Future work will more closely examine how the students are using the space and whether it can be better designed to enhance social interactions.

KEYWORDS

Identity, belonging, informal learning spaces, first year

Introduction

The Monash University Clayton campus is located in Victoria, Australia - one of the most locked-down areas in the world during the COVID-19 pandemic. We have observed that the transition to first-year university studies from 2022 onwards has been impacted by the pandemic, with attendance on campus lower than pre-COVID levels, increased applications for special consideration in assessments, and as reported in this study, low self-ratings of social interaction compared to other domains of belonging. We want to do everything we can to provide a safe, supportive campus environment to help our students succeed in their studies. Hence, we piloted the First Year Learning Centre (FYLC) in Semester 1, 2023 with the aim of supporting students to return to campus-based learning, improving class attendance and engagement, and supporting student success in team-based projects.

This paper examines previous evaluations of informal learning spaces in order to inform and validate our design. In addition, our evaluation will provide useful feedback to others intending to implement similar spaces in their institutions. The FYLC includes a collaborative furniture layout, 3D printers, electrical test rigs, whiteboards and free Milo (an Australian malted milk drink synonymous with happy childhoods, also popular in Malaysia and Singapore). We sought feedback on the space and evaluated its effectiveness in enhancing engineering identity and belonging through a survey and pilot focus group. Students gave positive feedback on the space, especially appreciating the 3D printers, the space to work on team projects and the Milo. Future improvements will include moving into a larger space, providing more 3D printers, and more varied furniture arrangements to allow for independent and pair study, as well as workbenches.

Background

In higher education, the provision of appealing informal learning spaces (ILS) is crucial for facilitating active and collaborative learning, social interaction, and networking, and fostering a vibrant and thriving ‘sticky campus’ culture (Matthews et al., 2011). Previous evaluations of engineering ILS found that they are often used by students for group work and socialising, and are more attractive when they include homely features such as couches and drinks (Quinn et al., 2011). ILS in discipline spaces have a stronger correlation with a sense of belonging, and proximity to food outlets is attractive (Hsu et al., 2022). For good utilisation of the space, it is important to accommodate students' preferences, which may not always be anticipated in advance, and students often re-configure furniture to meet their own needs. Again, refreshment is a constant theme in effective ILS design (Harrop & Turpin, 2013).

ILS should be aligned with the teaching and assessment approaches used in the classroom, for example, providing group seating spaces to support collaborative learning for team projects. Comfort and aesthetics are important considerations in the design (Riddle & Souter, 2012). Creating spaces specifically for first year students can reduce the social trauma of moving from a smaller high school setting to a larger university. Ideally, the space should be intentionally designed, and its evaluation focused on whether desired learning behaviours are observed (such as collaborative work) rather than trying to measure improved learning outcomes (Radcliffe et al., 2008). ILS are often implemented as part of a multifaceted approach to enhancing belonging. An effective ILS can be part of the suite of activities to support the student experience, especially the transition from high school to the first year of university, and effective spaces feel lived in and homely (Morieson et al., 2018).

Since teamwork projects form a significant proportion of the learning activities in the first year curriculum, our FYLC (shown in Figure 1) was designed within the physical space and budgetary constraints to facilitate these activities, with tables and chairs arranged in a collaborative format. There is a designated area towards the front of the room that includes a whiteboard where subject-specific staff can hold one-to-one or one-to-few consultations with students during scheduled helpdesk hours. Specialised equipment such as 3D printers and electrical test and measurement equipment, borrowed from teaching spares, are available on one wall of the room so that students can prototype and practise their skills with support from Makerspace and

subject-specific staff. The FYLC is open from 7:00 am - 8:30 pm and staffed for 4 hours each weekday by near-peer mentor Makerspace staff, who are senior students near the end of their degrees with specialist hands-on skills developed through extracurricular student teams such as Formula Student cars or Mars/lunar rovers.

Figure 1: First generation FYLC layout, Prusa 3D printers

Methodology and Methods

This study utilises a Mixed Methods approach, including quantitative data from utilisation and consumption metrics, qualitative data from observations and meetings, a questionnaire and a pilot focus group. Ethics approval was granted (Monash Human Research Ethics 38574).

Utilisation and consumption metrics

Students were instructed through signage and reminders from staff to sign in by barcode scanning their digital student ID card. Staff observed that sign-in compliance was not perfect, however, this data is useful to show patterns of access across different times of day and weeks in the semester, as well as the frequency of access per student. Accurate sign-ins were gathered during unit help desks, prompted by the unit staff. Free Milo was provided to students. Its consumption was measured as a proxy for venue utilisation by regularly weighing the Milo tin and tracking the usage of disposable, biodegradable cups. This data further illustrates access trends.

Observations and meetings

Staff regularly reported observations about the usage of the space through an online group chat, including any issues such as equipment maintenance and student requests for assistance. At an end-of-semester retrospective meeting, the staff team discussed their overall observations of the effectiveness of the space and suggestions for improvements in the following semester.

Survey

A survey was conducted via a questionnaire at the end of the semester to gather feedback on the FYLC, intended to investigate any differences between students who used the FYLC and those who did not. The questionnaire was open to all students enrolled in a Level 1 engineering subject and was advertised by a staff member who was not a member of the first year teaching team, on online forums and by direct email to students who had signed into the FYLC.

The questionnaire was anonymous and all questions were optional with the exception of a branching question (“Did you use the First Year Learning Centre?”). A chance to win a 1.9kg tin of Milo was offered as an incentive to participate, with entries collected in a separate form to decouple them from responses. Demographic questions were included where they could be normalised against the whole first-year cohort through other data sets. Students could indicate their international or domestic status and gender. Students were asked the distance they live from campus in minutes to allow for comparisons between on and off-campus residents. All these questions were optional and followed best practice guidelines for gender diversity and inclusion.

The questionnaire instrument development was informed by a review of previous studies to understand the norms and leading practice for evaluating learning spaces, identity and belonging. One complication is that there is no consensus on a validated instrument for measuring belonging. Building on a comprehensive review of the literature on belonging, Allen et al. (2021) propose an integrated framework for belonging, which includes four components: Competencies, opportunities, motivations and perceptions of belonging. The questionnaire was developed to measure target factors against each of these components, drawing on previously successfully used questions from the literature on evaluating engineering learning spaces where possible. The Likert questions used a 5-point scale, plus an option for "not applicable" or "don't know". The opportunity component is considered to be the FYLC intervention being evaluated. Allen et al. also propose that belonging is a dynamic feeling that changes over time. This questionnaire represents a static moment in time, a limitation that could be addressed through future studies.

Table 1: Likert scale survey questions

Domain	Sub-Domain	Target Factor	Question
Belonging	Motivations (Chang et al., 2009)	Enjoys interactions	I enjoy talking about engineering with my classmates
		Seeks out connections	I regularly interact with other engineering students outside class time
	Perceptions (Lindeck et. al., 2022)	Identity	I feel like an Engineering person Which of these images best reflects how you identify with the engineering profession? (Watts et. al, 2023)
		Interest	I am interested in the engineering course material and concepts
		Subject competence	I understand the engineering course material and concepts
		Interpersonal (feels connected)	I feel socially connected to my peers in engineering
	Competencies (New for this study)	Skills related to connecting (communication and teamwork)	I can communicate effectively with my teammates to achieve a positive outcome
		Critical self-reflection	I often think about my performance and ways I can improve
Engagement	Attendance (Chang et al., 2009)	Class attendance	I regularly attend my scheduled engineering classes (workshops, practicals and laboratories)

Open-text questions were included to gather feedback on what was useful about the space, what could be improved, and anything else the students wanted to tell us about.

The survey instrument was validated through three means:

1. ChatGPT 4.0 was used to provide feedback on the Likert scale questions, prompted with: *What do you think about the validity and reliability of these questions?* The feedback was in line with best practices from qualitative research texts (Dewar et al., 2019).
   Tell me what you think I'm trying to measure with each question. The questions appeared to be measuring the target factors.
   What are the possible incorrect interpretations of those questions? Minor changes were made to the wording of questions about peer interactions to improve clarity and simplify the language used based on feedback from the AI.
2. Peer feedback was provided by two education-focused engineering colleagues, who tested the survey flow. No errors were detected and the wording was thought to be appropriate for the intended audience.
3. Pilot testing was conducted with 5 first-year students who were asked to complete and then give feedback on the survey. In response to this, a minor change was made to the wording of the Venn diagram identity question (shown in Figure 2) from "Engineering community" to "Engineering profession".

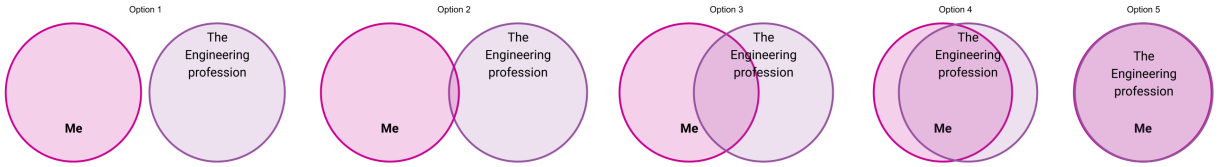

Figure 2: Which of these images best reflects how you identify with the engineering profession?

The survey responses were analysed using Qualtrics Stats IQ to test the correlation between responses to different questions. A thematic analysis was performed on the open-text questions to rank the most common feedback themes.

Focus Group

The survey is intended to find out what is happening in the FYLC and if there are any impacts on belonging, identity and the student experience. The focus groups are intended to dig deeper, to find out how informal learning spaces can support students academically, and to develop belonging and identity. At the time of writing, a pilot focus group was conducted with two students who gave feedback on the design of the next iteration of the FYLC space. Potential focus group attendees opted in at the end of the survey, however, the mid-year teaching break stifled efforts to recruit the groups in time for this paper. Larger focus groups will be conducted during the next teaching period.

Results

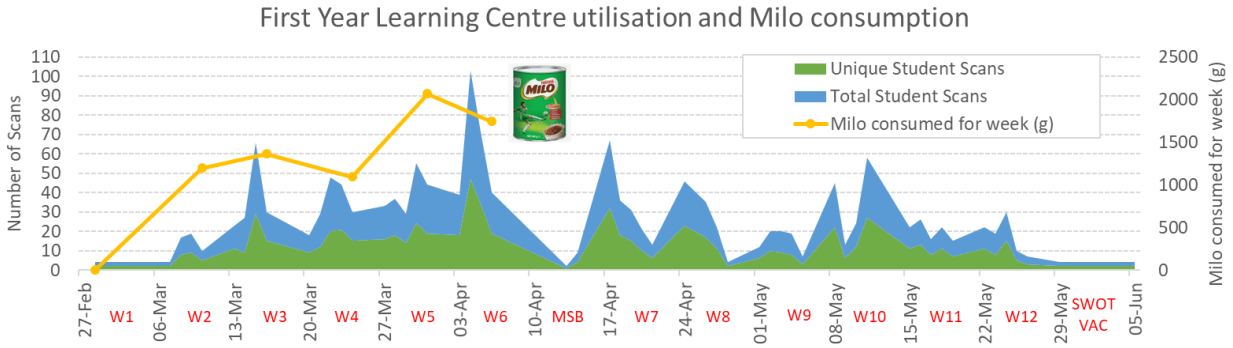

Figure 3: FYLC utilisation and Milo consumption results across 2023 Semester 1.
MSB = Mid Semester Break, SWOT VAC = Study Without Teaching Vacation period. Major assessment weeks: 6, 7, 10.

Utilisation

Figure 3 above shows the utilisation of the FYLC measured using two techniques: by total and unique student ID barcode scans, and consumption of Milo per week, measured in grams.

There were a total of 809 cumulative ID scans across the semester from 237 unique students. Scan compliance is assumed to be low, based on staff observations and statistics of “scans per unique student” (max: 47, mean: 3.4, median: 2, mode: 1). 94% of survey respondents who used the FYLC said they did so more than once. Measurements of Milo consumption provide a triangulating source of data that indicates the patterns of usage throughout the semester. The 1000th cup of Milo was served on the 23rd of May, although the cumulative number of sign-ins by that date was 779. It is a noted limitation that data collection of Milo consumption was terminated halfway through the semester, for reasons undetermined. More robust techniques to measure FYLC utilisation are being explored, including digital twins, anonymised people counting and movement tracking.

Peaks in utilisation naturally occurred in weeks where subject-specific assessments occurred (W6, W7, W10). Interestingly it appears that students did not use the space for collaborative study during SWOT Vac, even though subject-specific help desks were still scheduled to run.

Feedback

A total of 131 students responded to the survey. As all of the questions were optional, the following percentages are of the total for each question. 90 students (79%) had used the FYLC, 24 (21%) had not. Students who used the FYLC primarily learned about the space from a friend, on the first year Moodle site, from a teaching staff member, or through a Moodle announcement. 73 students (85%) recommended the FYLC to a friend. For students who did not use the FYLC, common reasons were that they didn’t know it existed, they didn’t know where it was, they were put off by the nearby construction zone, or they preferred to study in other places like the library. This indicates that advertising and directional signage can be improved in future semesters.

Feedback regarding the space was overwhelmingly positive. The two most useful and appreciated features of the FYLC were the 3D printers and the free Milo with the provision of alternative milk (oat) as well as dairy. Students also found the space useful for working on team projects. Several students referenced the whiteboard as a useful and entertaining feature of the space - it evolved over the course of the semester as an “old-school message board”, to advertise student society activities, queue for 3D printers, share song requests, jokes and gossip. Thankfully, this was effectively self-policed by students with a no-student-names policy.

Regarding improvements in the FYLC, the most common themes were requests for more 3D printers, a bigger space, and staff management of milk expiry dates, as new milk bottles were frequently opened before the old ones were finished.

Attendance

There was no statistically significant relationship between the use of the FYLC and self-reported class attendance. Students who live further away from campus were slightly more likely to have used the FYLC than those who live closer.

Engineering Identity

There was no statistically significant relationship between the use of the FYLC and “feeling like an Engineering person”, or the ratings on the Venn diagram scale.

However - there was a statistically significant relationship between gender and ratings on the Venn diagram scale ($p=0.00547$). Women rated themselves as further away from the engineering profession than men. Gender fluid/Non binary/Not listed/Prefer not to say are not published here in line with safe reporting guidelines due to a small sample size. The potential implications of this

result are examined in the discussion section. It appears that the Venn diagram format is an effective way to observe differences in perceptions of engineering identity in this cohort.

Table 2: Which of these images best reflects how you identify with the engineering profession?
(Images related to Options can be found in Figure 2)

Convergence of personal and engineering identity	Women n=43	Men n=62
Option 1 (no overlap)	2.3%	1.6%
Option 2 (slight overlap)	36.4%	9.7%
Option 3 (half overlap)	40.9%	43.5%
Option 4 (mostly overlap)	13.6%	38.7%
Option 5 (fully overlap)	6.8%	6.5%

Belonging

Most of the Likert scale questions achieved rates of agreement around 90%, where strongly and somewhat agree are aggregated to give overall agreement. The three least positively rated questions were: I feel like an Engineering person (77% agree), I regularly interact with other engineering students outside class time (64% agree), I feel socially connected to my peers in engineering (63% agree). There were no statistically significant relationships found between the Likert questions and the use of the FYLC.

There were statistically significant relationships between two of the Likert scale questions and gender: I understand the engineering course material and concepts (women 14% vs men 40% strongly agree) and I enjoy talking about engineering with my classmates (women 23% vs men 55% strongly agree).

Discussion

While the intent of the study was to determine if the FYLC impacted students' sense of belonging and engineering identity, significant results were seen only at a representative first year cohort level, or between genders. Further study is required to determine the source of these differences.

The questionnaire respondents represented around 10% of the first year cohort, with a similar international/domestic split and a slightly higher representation of women than enrolled first year students. In the questionnaire, women rated their engineering identity and their self-perceived subject matter competence lower than men. This is in line with other studies in the area, however it is interesting to note that these differences are present during the students' first semester of university, implying that this came about based on cumulative past experience not through their university studies. Women rated their enjoyment of talking about engineering with their classmates lower than men, at this stage we cannot determine why, but it would be interesting to interrogate whether this is about perceptions of what the engineering discipline is, and/or whether they do not enjoy talking to their classmates.

In the questionnaire responses, the first year students rated their agreement lower on the questions regarding social interaction. It is not known at this stage whether this is a post-COVID phenomenon, potentially due to minimised opportunities for interaction through years 10 and 11 of high school, or whether this is specific to students choosing to study engineering. As there was no pre-COVID baseline, this could potentially be determined through further focus groups and any changes observed through a potential longitudinal study. Students did state in the questionnaire responses that socialising was a common reason for using the FYLC.

Feedback was gathered from the pilot focus group on how well the space was operating. They appreciated Makerspace staff assistance with 3D printing but noted that printer queueing could be improved during busy periods. The focus group validated the second generation design for the FYLC (shown in Figure 4), particularly remarking on the improved diversity of types of working spaces, with new individual and pair study spaces and a couch area. They are very much looking forward to having plants in the space, although they remarked that if the space looked too polished or commercial, they might hesitate to use it for “messy” engineering activities.

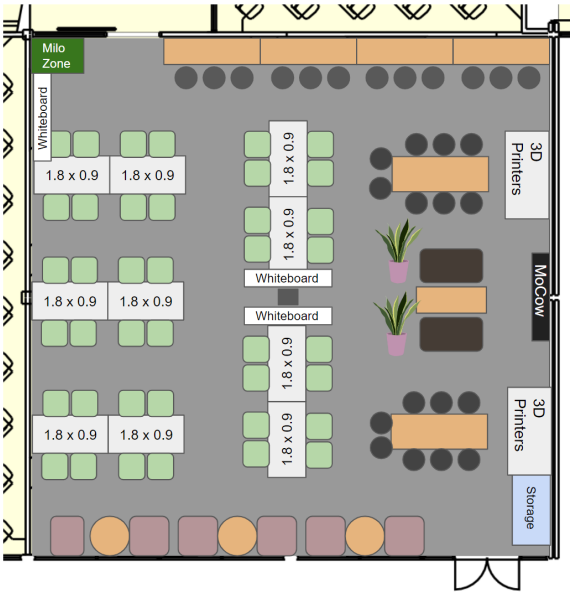

Figure 4: Second generation FYLC layout, room roughly twice the size of pilot space

The focus group participants mentioned that a key difference between the FYLC and the library, in that noise and buzz of discussion was a social norm of the FYLC, whereas the library is a place to go for quiet study. There were no rules set for the FYLC, other than abiding by the university code of conduct and adhering to OH&S requirements for 3D printing and using electrical test rigs. All ‘rules’ were actually norms set over time by the users of the space, and policed by those users. The focus group stated that this gave the users a sense of ownership and responsibility and that they appreciated that the space felt uncontrolled by academic staff, although they were very happy to engage with staff during subject-specific helpdesks.

An issue raised by the two pilot focus group participants and several of the Makerspace staff (all women) was the smell of body odour in the space during the final week of the semester. This is important to note as a factor stated by women anecdotally as a barrier to using the FYLC and the computer lab building in which it is housed. Therefore, mitigating the odour may create a more inclusive environment, and improvements to the ventilation system will be requested.

Overall, it is clear that the FYLC is well utilised and valued by students, particularly the access to 3D printing, space to work on team projects, free Milo and space to socialise between classes.

Conclusion

The FYLC was well utilised, with the current room overflowing during assessment submission weeks. Demand for 3D printers seems inexhaustible - funding will be sought for more printers. Feedback on the space was overwhelmingly positive. Differences were observed between women and men in their self ratings of engineering identity, subject competence and social interactions. All students rated social factors lower than other factors of belonging. No clear differences were seen between students who used the FYLC and those who did not. The current study was limited by the availability of students to join the focus groups. Future focus groups will investigate the reasons for the above differences. Trajectory studies and interviews will be conducted to inform and optimise the design of the FYLC and future informal learning spaces.

Recommendations for designing an informal student learning space

- Provide ample power infrastructure for student devices
- Allow students to develop their own norms and ownership of the space, rather than making rules (except where required for safety and wellbeing)
- Provide something to attract students to the space - 3D printers and free drinks work well
- Induct and train students to use 3D printers independently. Maintaining printers daily maintains maximum uptime, without needing constant supervision. We do not allow unattended or overnight printing to avoid faults and allow fair access to printers.
- Provide alternative milk options (oat is popular and a more sustainable choice)
- Allow students to use AV and whiteboards freely
- Ensure furniture is comfortable, but not large enough to be used for sleeping
- Providing near-peer mentors supports students without them feeling overtly supervised

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