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Interdisciplinary Engagement in Higher Education: Opportunities Explored

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Abstract

There are increasing pressures on universities to make their graduates ready for life and work, in addition to ensuring technical and professional competence. This chapter discusses the implications of supporting such an approach for higher education in a university in Australia where the university was treated as an urban living lab, supporting student engagement for a course innovated to cover three different disciplines. Urban living labs are a form of collaborative partnership particularly in urban areas to support sustainability outcomes. The innovation presented here was in using a green building on campus, bringing students from different disciplines, to study this green building, thereby also partnering with industry. The key question driving the research was whether academic-industry partnerships may be used to understand the performance of green buildings on an urban campus. The anchor course was in construction management and the other disciplines were business and computer science. Twenty three students undertook study of predetermined spaces of a green building on campus. The results show that as a pilot study, this project was successful, with good engagement of students, teaching and non-teaching staff from the university and industry. However, it was more difficult to convert the pilot to mainstream teaching and learning.

Keywords: Australian, university, innovation, built environment, students, sustainability, urban learning labs, green buildings, interdisciplinary, transdisciplinary

1. Introduction

Sustainability is about tackling real-world problems. To meet the needs of the Sustainable Development Goals, New Urban Agenda and future challenges, built environment professionals face unique challenges. The work of designing, procuring, financing, renewing and maintaining the built environment is undertaken by professionals who are being confronted with incorporating new knowledge and professional practices into the way they produce and renew less carbon and water-intensive built environments. Higher educational institutions the world over educating built environment professionals, such as in architecture, engineering, building, construction management, project management and urban planning, are being tested to renew their curricula and research capacities so that their graduates can contribute more to urban sustainability. While industry and government have responded to some of our current sustainability challenges by developing rating

tools and regulations for reducing energy and water use in the built environment, academia and curricula in the built environment have not kept pace with these challenges.

This chapter focuses on innovating an existing course to support student learning outcomes while also understanding how buildings are performing on an urban university campus. This is undertaken by exploring the sweet spot between using a green building on campus as a living laboratory for education in construction management, business and computer science students and structuring the curriculum for not just meeting academic outcomes, but also considering building performance from a user perspective. This brings in a real-world context, engagement with industry while also aligning sustainability outcomes of the university. The chapter focuses on curricular innovation engaging cohorts of students from different disciplines, while also preparing students to work in the real world where employees may work across diverse work groups. This was undertaken by innovating the curriculum, with very little change to the course and programme learning outcomes.

The primary question driving this research was to explore whether a green building on campus may be used as a vehicle for engaging students from different disciplines while also working with industry. Secondly, what learnings may be gleaned from such an approach and can student-academic-industry partnerships be strengthened in the future particularly for built environment education? A case study [1] approach was taken for this innovation trialled as a pilot and catalysed by a state government grant.

The overall findings of this study resulting from stakeholder engagement, student interactions, assessments, course and programme learning outcomes and teacher participation have already been presented [2]. This chapter focuses on the curricular innovation and the process that supported it, and related student and teacher experiences. The chapter commences with a literature review of universities and their responses to sustainability, followed by sustainability integration in built environment curricula focusing on innovation in particular. This is followed by an explanation of how a course was modified to incorporate student and industry engagement for a building on campus for the three disciplines considered. The findings of this engagement have been analysed from the building performance perspective, student and teacher experiences followed by some general discussions with conclusions at the end.

2. Universities and sustainability

The twentieth anniversary of the Tbilisi Declaration (1977) [3] was celebrated through an international conference in Thessaloniki, Greece, resulting in the Thessaloniki Declaration [4]. These are some of the earliest attempts for bringing in education for environment and sustainability, and these early attempts to include the environment have now been expanded to include beyond environmental concerns to social and economic concerns for sustainability. Further to this are the 'newer' challenges of also considering climate change, adaptation and resilience, particularly since the United Nations Sustainable Development Goals were adopted in 2016. There is a lot written but still not much evidence in practice on sustainability becoming mainstream since the first conference on sustainability in Rio in 1992, and the most recent conference in 2012, that capacity building for sustainability needs to be urgently addressed. The importance of refocusing on sustainability education, particularly, in light of the current challenges to the built environment

has been discussed [5]. The author indicates that supportive platforms to encourage and learn from each other for understanding and engaging with sustainability in the built environment are required as local contexts vary.

Filho [6] posits that while there are many problems preventing universities from implementing sustainable development as part of their programme, there are also opportunities to be explored. Filho et al. [7] state that while universities are now incorporating sustainability principles into practice, transformational changes in society to address sustainability concerns have yet to be seen. They report successful cases at the Hamburg University of Applied Sciences and Bournemouth University in the UK, where research and teaching on sustainability have been successful, so also extension into the community through capacity building and other such activities. These examples have deliberately moved away from traditional models of university operations, by investing time and effort to work collaboratively across professional and practitioner domains beyond traditional disciplinary silos. Transdisciplinary engagement is really critical if true sustainable development is to be achieved.

Lozano et al. [8] discuss the importance of moving away from traditional models of teaching and learning, if universities are to become leaders and change drivers. Universities need to engage with sustainable development principles and paradigms; they need to educate themselves before they can educate others. Universities are organisations that are typically slow to change. While universities are involved in the business of education, they are also involved in research and scholarship and in looking after and maintaining their own buildings. Shiel et al. [9] argue strongly the critical role universities play in community development, and a key tenet of that engagement is prioritising sustainability outcomes.

Velazquez et al. [10] note the various factors that may obstruct the implementation of sustainability initiatives in higher educational institutions. They argue that the current focus tends to be on good experiences rather than examining how these good experiences have *evolved*. Likewise, with the bad experiences, the learning itself is not supportive enough to ensure that other people and organisations *do not* make the same mistakes. Failures, therefore, may be used as a learning experience particularly when considering institutional barriers in particular situations. Among the many factors identified with respect to barriers are: lack of awareness, interest and involvement; organisational structure not supporting sustainability outcomes; lack of funding; lack of support from university administrators; lack of time; lack of access to data; lack of training; lack of opportune communication and information; resistance to change; focus purely on profits; lack of more rigorous regulations; lack of interdisciplinary research; lack of performance indicators; lack of policies to promote sustainability on campus; lack of standard definition of concepts; lack of designated workplace; lack of standard definitions of concepts and male-dominated workplace, not supporting 'softer' skills required with sustainability outcomes.

Trencher et al. [11] state that there is increasing focus now on the co-design and co-production of knowledge and solutions for advancing urban sustainability. Their research to understand the features of university partnerships across many areas also included the role of diverse actors, and they sought to identify drivers, barriers and impacts. Their study found that while quantitative measures such as energy, buildings, governance and social systems are integrated well into local scales, individual partnerships are important for making strong environmental and sustainability impacts; and academic, industry and government timelines are not always in sync. This has also been echoed by Pereira et al. [12] examining the relationship between the environmental management practices at a campus of a

Brazilian university and the greening of its organisational culture. The university bureaucracy and hierarchy got in the way of implementing and delivering on an environmental management programme for the university and the key performance indicators of the teaching staff was focused on publications not on practice or supporting practical outcomes.

Urban living labs or laboratories (ULLs) offer another model of participation, collaboration, experimentation, learning and governance particularly where low carbon and sustainability outcomes are desired [13]. They may be applied across cities, where geographical embeddedness, experimentation and learning, participation and user involvement, leadership and ownership, and evaluation and refinement form the key characteristics of ULL. ULLs offer a type of partnership that enables the co-production of knowledge and often support innovative solutions. Hence, ULLs may be seen as a form of partnership, they may be seen as forms of experimentation or they may be seen as opportunities to test a product, service or technology. ULLs are test grounds in a real-world environment and, thus, are very context specific by definition. Therefore, ULL requires contextualisation and translation to other urban realities [14].

Evans et al. [15] describe the establishment of living labs at the University of Manchester where teaching and learning and research on sustainability were trialled. They also use a co-production approach where diverse stakeholders get together to co-produce knowledge in real-world settings. Living laboratories offer an opportunity to push the boundary for innovation of collective urban governance and experimentation to address sustainability challenges and opportunities created by urbanisation [13, 16]. The greatest advantage of using living labs is the engagement with students and staff for applied sustainability issues.

Similarly, the role of campus, curricula and community in higher education has been discussed [17] where universities can clearly play a leadership role in being exemplars of sustainability for the community. The importance of engagement of students in university campuses may be seen as opportunities for interaction with the real world and these offer prospects for curricular innovation as well.

Thus, urban universities may function as living labs. Chambers [18] shows how the University of Melbourne in Australia is working to become a sustainable organisation. They were able to do this by supporting recycling initiatives on campus; supporting teaching, research, community engagement and education, and operations through the development of a green roof on one of their campuses and pushing innovation through the development of a shallow geothermal system on their main campus.

The research undertaken is set against the background of universities acting as living labs for engagement with students and the wider communities. At the same time, universities are also working to improve the sustainability outcomes of their own campuses by reducing resource use, energy and water. Often, learning outcomes and anticipated student attributes between academia and industry are not quite aligned. While academics tend to focus on discipline/competence, industry tends to focus on wider inter- and transdisciplinary attributes. Using campuses as learning labs offers an untapped opportunity for universities to walk the talk and show students that universities can become exemplars of sustainability models.

The next section examines how built environment curricula have dealt with integration of sustainability in their programmes.

3. Sustainability in built environment curricula

Built environment curricula have largely tended to focus on imparting technical skills to students. This may be attributed to pressures of accreditation, focusing on

the competencies graduates need to gain entry as a professional and to practise in a built environment profession. Certainly, in Australia at least, the focus of employers in most disciplines including the built environment has shifted from purely technical or professional skills. Employer perspectives on work trials and work experience indicate that they are looking for employees with 'an interest in the industry and personal attributes such as good communication skills, a willingness to listen and learn, a positive attitude and good work ethic' [19].

There is not much in the literature by way of practical application of how built environment educators may approach either interdisciplinary education or innovation in the classroom, particularly where the subject content is about engaging on sustainability underpinnings. By its nature, sustainability requires an action-oriented practical approach. Yocom et al. [20] indicate that deliberately keeping a built environment studio experimental supported students to pursue new approaches and suggest alternative approaches and disciplinary responses. Developing a collaborative understanding between students was more difficult and communication is essential to tease out the issues and develop shared understandings. They highlight that adjusting pedagogical frameworks is an important aspect of education today and into the future.

Posch and Steiner [21] strongly endorse linking innovation with inter- and transdisciplinary underpinnings. An integrated process of knowledge production, they argue, is bringing together scientists and practitioners in a real-world context to produce more robust societies. Transdisciplinary approaches may be seen to be an instrument in a common process of inquiry beyond problem-solving and mutual learning. Knowing, understanding and applying in a circular or non-linear approach enable students and other learners to gather knowledge as a tool for problem-solving in real-world situations. Along similar lines, Callaghan [22] discusses how a reflective collaboration framework can support academics to find unique solutions in different academic contexts. He sees this as an opportunity to collaborate across traditional disciplinary contexts, providing unique problem-solving opportunities. Informal collaborations may also support formal collaborative practices.

Some level of contextualisation is required, which needs to move away from prescriptive approaches. This is the case for built environment engagement [5] as well as in other areas intersecting with the built environment such as for disability planning [23] and also where health and built environments intersect [24]. The literature has some examples of interdisciplinary and transdisciplinary underpinnings in curricula, but not many applicable for the built environment, and examples particularly using urban campuses for academic-industry collaboration. One thing that is commonly seen though in the literature is that innovations of some form, quite distinctly different from traditional pedagogies, are essential components of change. Hence, the next section focuses on innovation.

3.1 Innovation for education for sustainability

Innovation for sustainability responds to issues that are relevant for society, and where innovation becomes the underlying platform for problem-solving approaches, it is an essential element to creative thinking and practice for sustainability in the built environment. The role of interdisciplinary, intradisciplinary and transdisciplinary approaches as indicated in the section above is therefore critical, as is the context. Taking a systems approach to innovation for sustainability also presents its own challenges, particularly with respect to temporal issues, which may need further development and understanding with feedback over the time of the project/engagement with the users.

Taking an example of the real world, Nidumolu et al. [25] show in their research that sustainability underpins organisational and technological innovations leading

to both top-line and bottom-line returns. Smart companies treat sustainability as innovation's new frontier. As discussed by Barbieri et al. [26], the role of various actors is critical for generating, implementing and diffusing technological innovations. As universities are responsible for educating vast number of students, it is critical they are constantly innovating across teaching and learning, research outcomes and the application of this knowledge.

In a study in the UK at the University of Salford [27], the development and implementation of an interdisciplinary course in the final year for five different built environment disciplines showed that both staff and students felt that the course was successful. However, feedback provided also indicated that sufficient time was not allocated for delivery and management of the course. Assessment criteria also needed more work.

Innovation in education has inherently been linked with technology; however, it may also be linked to teaching practices, curriculum development and learning [28]. Innovation in education needs to be proactive, it involves knowledge transfer and, therefore, the process of transfer: the 'why' and 'how' rather than the 'what' becomes the focus. In a study across four universities in Australia [29], the authors show that communities of practice supported to build collaborative relationships of trust and reciprocity between teachers in a wide range of disciplines. Their study was able to integrate diverse disciplinary perspectives, teach collaboratively, promote innovation through exchange and, by doing these, demonstrate leadership within their own institutions. In another study, also in Australia [30], it is shown that collegiality and support for teaching innovation were a primary measure of success; however, increased workloads and lack of time were also reported by the participants. As administrative structures are predominantly discipline-based, if such innovation is to succeed in the long term, early adoptive measures for interdisciplinary teaching need to be supported by financial and other resources to be fully embedded.

The Faculty of Built Environment in UNSW underwent a radical change in 2012, where there was a deliberate attempt to bring in inter and transdisciplinary engagement through a faculty-wide initiative called the common learning experiences [31]. This was seen as an innovative approach by the school. These experiences not only embedded interdisciplinary experiences in the faculty's undergraduate curriculum; it was also supported by staff through a process of ongoing engagement and supported by the leadership team of the faculty.

Using an example of an environmental subject in the sciences [32], Simon and others show that curriculum design, engagement in small groups and field trips outside the classroom supported interdisciplinary understandings in undergraduate curricula. In yet another example on development of a sustainability course, it was found that engaging teaching staff from various disciplines supported organisational change to become a core course in a university-wide programme on sustainability.

Alongside formal curricular changes, the informal curriculum is also seen to be significant. Winter and Cotton [33] refer to 'informal curriculum', extra-curricular activities and student activities linking estates and operations to formal study. Such informal curricula, they believe, have been overlooked as potential influence on student learning and behaviour. Using the UK experience, the authors state that helping students deconstruct the hidden campus curriculum may enhance aspects of sustainability literacy, developing students' understanding about sustainability and creating solutions to sustainability issues, enabling evaluative dialogue around campus sustainability and also self-reflection, which could be transformative and translate into pro-environmental behaviour change.

Beyond the built environment disciplines and attendant curricula, and examining the integration of sustainability in business disciplines and curricula show that most business schools are focusing on 'piggy backing', 'digging deep',

'mainstreaming' or 'focusing' their sustainability and ethical approaches to curricula [34]. Each of these curricular approaches refer to 'blending' approaches where they may be added to existing courses in a very narrow curricular context of piggy backing, and development of new stand-alone structures through digging deep. Mainstreaming is still tinkering with existing structures but taking a broader curricular approach of emphasising cross-curricular perspectives. Focusing also takes a broader curricular approach where new structures are created through new cross-disciplinary offerings including new programmes.

Therefore, curricular changes are not simply a matter of 'academic' engagement; it is also about its holistic interaction about engagement with students, teaching and non-teaching staff and strategic outcomes for the university.

4. The anchor course and innovation

The innovation of the course (subject) was deliberately not set up as a new multidisciplinary course for students from different disciplines as the timeline to do so was not considered to be practical. First, an anchor course was needed to allow innovation for student engagement on campus. As the project leader was from a built environment school, the anchor course logically rested within this school. The school offers undergraduate programmes in property and valuation, construction management and project management. Other built environment programmes such as planning, architecture and landscape architecture are part of other schools. The anchor course selected was a construction management course on research; so, it was relatively easy to bring in building post-occupancy study as part of the research course. The course was undertaken in the final semester of the final year of construction management students. The students were encouraged to solve an authentic industry problem or address real issues within the various professions. The students were encouraged to seek question/s, collect and evaluate data, analyse and report their findings and recommendations.

Second, since the intent was to use the campus as an urban living lab, a building was selected for the study. The building selected was where the author had already undertaken a post-occupancy survey to understand if the green building met its intended performance targets. In the post-occupancy research, staff and higher degree by research students were involved and also key stakeholders such as the architects, project managers, builders, various ESD (environmental and sustainable design) consultants and the facilities managers of the building and the property services section of the university were engaged in the research process. The green building was completed in 2012 and staff and students moved into the building not long after mid-2012, just prior to the commencement of the second semester that year. The outcomes of the post-occupancy evaluation focusing on staff and higher degree by research students, stakeholder engagement and its learnings from various perspectives have already been presented [35–38].

Third, innovation was required for students to engage with industry, the building occupants and other stakeholders. But, as the literature demonstrates, innovation is also about engaging students beyond their own disciplinary boundaries. Therefore, at least two other schools, attendant courses, teaching staff and students needed to be engaged. Through informal discussions, teachers from two other disciplines interested in cross-disciplinary engagement expressed interest. They were from business and computer science. Each of the business and computer science courses selected was such that industry engagement was part of the course requirement. Industry stakeholders acted as mentors to support student learning and

provided industry input as appropriate. This included an industry mentor's input through the formulation of the research question/s itself, situating the research with industry, data collection, analysis and evaluation as appropriate.

Thus, innovation lays in not just using a building on campus, but also with understanding the sustainability underpinnings, engaging with industry and working with students from other disciplines to promote transdisciplinary engagement. The opportunity for innovation in the course came in the form of an application and, eventually, as successful recipient of a grant undertaken through a state government competitive grant process. The objective of the grant was to support students and future designers to learn from real-world problems and suggest improvements in the design and post-design process. The grant supported employment of an assistant for project management and administration.

Thus, students from three different disciplines were brought together to study different aspects of the building. The engagement of the different student cohorts supported multidisciplinary engagement in the urban living lab. The process for engagement with each of the disciplines has been provided below.

The initial idea of engaging with the business and computer science students was to also seek students in the final years of their programme, undertaking a research component. It was not realistic to set up a new course with common course learning outcomes across the three cohorts of students as this required a two-year lead time to go through administrative processes within each of the relevant schools and university to set up a multidisciplinary course. Moreover, the timing of receiving the grant and its contractual obligations did not allow equivalent levels of engagement with the business and computer science students as, again, administrative processes and securing commitments from relevant course coordinators took time.

Clearly, the university's property and facilities services department needed to be involved and this was not a problem due to the relationship the project leader had with the said department owing to previous research undertaken on post-occupancy evaluation of the building. Since students from three disciplines, teaching and non-teaching staff and industry were involved, ethics clearance from the university was needed and obtained before commencement of the course. Students were surveyed at the end of the course across all the disciplines as normal for any course undertaken in the university. Although a survey was deployed specifically relating to this course, it did not provide any insight as the survey was deployed quite late in the semester.

4.1 Student engagement

As explained in the previous section, the catalyst for student engagement commenced with construction management students undertaking their final-year research projects with the author of this paper being their supervisor. A total of nine students in groups of three each studied various components of the building. Computer science students were much older students and they were in the final semester of their Masters by course work programme. Business students were in their final year/final semester of Bachelor of Business programme. Eight computer science and six business students participated in the study of this building. For the computer science and business students, the course was part of an existing course, similar to the construction students, although it was not a research course.

Spaces to be studied by the students in the green building included student portals, teaching rooms and one café. The students engaged in three workshops: one at the beginning of the semester, one in the middle of the semester and one at the end. The workshops included the academic coordinators/supervisors for the three cohorts of students, the students themselves, and the industry stakeholders such as

the architects, project manager, building managers and property services staff of the university. The first workshop was to explain the project, identify the spaces and do a general walk around in the building to view the various spaces in the building and get a sense of user interaction. The second workshop was for students to present their interim work and seek feedback from the industry stakeholders (including appropriate university property and facilities staff). The final workshop was for students to present their work and seek feedback.

The construction management students undertook a thermal comfort study of the building examining the specific predetermined areas in consultation with the design and project architect and the building manager of the green building. The construction students focused on day lighting, ventilation, thermal comfort and acoustics, and used appropriate instruments to gather this information. The business students observed and interviewed fellow students and staff in these spaces to understand whether user needs were met. The computer science students prepared an application (app) to be trialled in these spaces by their fellow students and staff to understand the use of space and attendant user needs.

The intent was that all three cohorts of students would undertake their research at the same time so as to minimise disruptions to their fellow students and staff. The students agreed at the first workshop the dates/times when they would do this over three weeks in the semester (weeks 2–5) so that they could then share these findings with each other and report during the second workshop. Students across the three cohorts engaged with their own lecturers/tutors as required to assist their learning throughout the course of the semester. Each cohort of students had to meet the interim and final assessments in their course. So, the student engagement was designed to meet the learning outcomes for all the three courses.

The project leader and teachers involved across all three disciplines attended the three workshops and engaged with students and industry (separately and together) at various times during the course of the semester. They also met each other at periodic intervals to discuss student engagement, course learning outcomes and student experiences. No other formal survey was undertaken specifically for these students other than the standard course experience survey undertaken by the university.

5. Findings and discussions

As indicated, overall experiences of this study have been presented in another paper [2]. With the scope of this chapter being on course engagement and innovation, these aspects are delved into further detail in this section. The findings of the students' evaluation of the green building, their engagement and experiences and those of the teachers are provided briefly in the forthcoming sections.

Generally, the coordination of the industry stakeholders, student and staff was a big challenge. Students' timetables invariably clashed, as did the teachers' availability to attend meetings to discuss students' work, engagement and course progressions.

The construction management students focused on the physiological and perception issues related to the environmental side of the building performance. The computer science students undertook an online survey, focusing on the environment and social issues pertaining to sustainability through the development and fine-tuning of their app. Their focus was on the environmental perceptions of comfort as their online tool needed to be finessed and mapped, and further fine-tuned. The business students focused purely on the social issues. However, the integration between the groups of students could have been done better.

The overall findings and learnings from this project have been summarised in **Table 1** and also presented in the sections below.

Issue	Pilot output/outcomes	Lessons learned
Overall coordination of the project	Needed more coordination than estimated.	Plan early and seek support.
Overall time spent on the project	More than estimated.	Factor in administrative time, seek both top-down and bottom-up support.
Course innovation		
Teachers involved in discussions and teachers involved in project not same	Limitations.	Involve the teaching staff and leadership team as early as possible.
Targeting the correct disciplines	Selection based on convenience.	Depending on study, disciplines will vary, need to involve property services department of the university.
Study of the building		
Green buildings may be used to seek industry-academic engagement as well as student learning	Successful pilot.	Green buildings may be used to support student learning outcomes. Industry-academic collaboration is possible but needs to be planned.
Thermal comfort study	Suits built environment students. This study used computer science and business students too.	Can cover a range of built environment disciplines such as property, construction, building, architecture and design, project management. Can include other disciplines such as engineering, agriculture, health.
Types of building/s to study	Office and teaching space, student portals.	May be extended to include vegetation/green areas on campus, café/eating areas, student residences, seminar rooms and other such spaces.
Student experiences		
Assessments	Integrated into existing courses.	For true transdisciplinary engagement, assessments would need to be set up appropriately.
Learning outcomes	Integrated into existing courses.	Learning outcomes would need to be set up for courses that are appropriately structured as a new course taking into consideration various disciplines.
Student interaction with other students between disciplines	Limited due to practicalities such as timetabling.	Course may be developed such that interaction of students is optimised.
Teacher interaction with students from other disciplines	Limited.	May be improved by ensuring better optimisation in timetabling and recognition in workloads of teachers.
Engagement with industry	The cohort that got the best value from the pilot.	Industry engagement may be further improved, for instance, industry may also be involved in assessments.
International and local students	International students got more value as their interaction with industry is usually limited in the programme due to various reasons. Local students are usually working even if not in the same discipline/industry.	Industry engagement for local and international students varies due to a range of different issues, context, age, discipline base and a range of other similar factors.

Issue	Pilot output/outcomes	Lessons learned
Teacher and stakeholder experiences		
Teachers involved in discussions and teaching not the same	Limitations: coordination between planning staff/leadership team and teacher may have been better achieved.	Better planning would ensure better communication between the teachers involved in course development and teaching. Recognition of workload issues would assist.
Senior management support	Limited.	Top-down engagement from senior management will support bottom-up engagement.
Industry stakeholders, including facility managers	Very supportive and got the most out of the project.	Industry engagement varies depending on the types of personalities involved. Relationships between teaching and non-teaching staff and students need nurturing and support.

Table 1.
Summary of the findings and learnings.

5.1 Overall course innovation outcomes

The primary question driving this research on the nature of academic-industry engagement to understand the performance of a green building on campus has been answered in the affirmative through the research. Urban campuses may be used as learning labs. As to whether these partnerships may be strengthened for built environment education is also in the affirmative. Sustainability education for built environment students may be undertaken using buildings on campus as educational opportunities. Not only built environment students but students from other disciplines may also benefit from a study of campus assets. However, putting this into practice is not straightforward. Curricular innovation requires injection of resources to put into practice.

The overall experience of the course innovation was that it was successful, but not without some limitations. Using a building on campus for student learning was a good idea, and it benefitted the university in doing so as they got information about what worked and did not work well in their own building. The green building findings, particularly student responses, were very similar to that of the staff who took part in the post-occupancy evaluation undertaken by the author and team post the completion and occupation of the green building [35–38]. Some of the challenges of comfort in the student portal areas and cafes have been addressed by the property services department of the university. Relationships with on-campus facility managers are needed to support green building outcomes; hence, nurturing these relationships between academic staff, students, industries and campus staff is quite important.

The course experience surveys did not reveal any specific point of success or challenge across students from all disciplines; nevertheless, the students' verbal feedback during the course of the semester was positive. Student course experience surveys deployed by the university did not separate the students involved in the study of the building from their peers. While an online survey was deployed specifically to capture student experiences involved in the study of the green building at the end of the semester, it was undertaken too late and students did not respond to this survey as they had already completed all their requirements for graduation.

The teachers involved in the course across the three disciplines were keen to share their experience with their peers, particularly to continue to engage students across

the disciplines in future courses. However, this did not happen in practice for several reasons. Firstly, the teachers did not end up being involved in the same courses that allowed innovative course learning and student engagement to be incorporated for the following academic year and continue on the successes built in the pilot. Secondly, the teachers who were teaching these courses in the following academic year were reluctant to add to their academic workloads as it required project managing across the disciplines, over and above the normal teaching/assessment times. Thirdly, the leadership team across the three schools did not particularly care for engaging their students on campus projects because it required engagement with non-academic part of the university, which again, requires more time involvement and relationship building. Fourthly, the time to select appropriate courses/disciplines that can meaningfully engage with university assets while ensuring the course and programme learning outcomes are aligned needs to be considered at the outset. Time is also required for project managing the stakeholders including the students and the teachers. If it had not been the grant that spurred the project, allowing a research assistant to be employed, the idea would probably never have taken off.

This pilot example shows that it is possible to provide a vehicle for engaging in real-world teaching and learning using a building on campus. Providing genuine transdisciplinary engagement and learning outcomes using an existing course with defined learning outcomes already is not possible. To do so will require development of new course/s to support learning outcomes that will genuinely engage students beyond their own disciplinary boundaries, along with appropriate assessments to support this. This needs time, and it also needs support from discipline leaders as well as strong engagement from teaching and learning services of the university to support such outcomes. Long-term planning for such a scenario is required. As Painter-Moreland et al. [34] argue, there needs to be a systemic institutional integration which can be defined as

'building a systemic capability towards sustainability, distributed and nurtured throughout the organisation, which creates the impetus towards change in students, faculty, administrators, the institution as a whole, as well as organisations that hire its alumni' (p. 743).

5.2 Green building findings

The student surveys and thermal comfort testing undertaken by the three cohorts of students included lecture theatres and other tutorial rooms, cafe and student portals. Rather than separate the findings for each of the cohorts of students, general findings have been presented. A general observation made by all students was that the building was very well used, with far higher utilisation rate than other buildings on campus. This was validated by the property services staff. Students liked working in the building, not just students from the business schools that were housed in the building, but also students from other schools across the university. This was largely because the spaces in this green building were comfortable, convenient and modern. Generally, spaces that were mostly liked by students were the lecture theatre, teaching spaces and the student portals.

In terms of room layout of the teaching spaces:

- Students were more responsive to learning with the way the rooms were designed. It was found that students found it easier to communicate with each other due to the room layout supporting student learning outcomes.

- Some lecture spaces used whiteboards. Frequent comments regarding the white boards were: *The whiteboards are difficult to teach with*. These comments refer to technical issues relating to the use of whiteboards, and the type of pens

to be used. This may seem a trivial matter, but since the technology was new, not all teachers knew how to use the special pens.

- Room layouts were not necessarily always conducive always to communication where eye contact between teacher and students could be maintained. There were situations where the room layout presented the person's back to the class while discussions took place.

- Placement of air vents under the chairs was not the most effective way to dispense air circulation in the space, as the few students felt quite cold at the end of the class.

- From a thermal comfort perspective, most of the teaching spaces were comfortable. Daylight levels were good, artificial lighting-supported day-lit spaces where required and temperatures were usually comfortable. Air movement was fine in most places and the teaching spaces were not noisy.

Feedback regarding common student spaces, including cafe, were as follows:

- Students complained of glare in common student spaces. *Sometimes, the sun shines in too strongly*, and its variations were comments often heard. Students needed to move around in these spaces as the day advanced.

- Few students preferred a designated quiet study area. They preferred to work with other students around (even though most students often used ear phones).

- Where there were designated quiet study areas, these did not work particularly well, as the acoustic separation was still a problem. Some students discussed their work creating issues for others.

- Students indicated that there were not enough power outlets. Almost 90% of students using the study area were observed to be using an electronic device and it was critical to provide more of these to facilitate student learning outcomes.

- Some spots in the building also had poor internet connectivity, which was a cause of frustration for some students.

- Unsatisfactory air flow in the café space, student hub, portals and common areas were also reported, making the space quite uncomfortable to be in for long periods of time, particularly during the winter when the study took place.

Student experiences of taking part in this course are presented next.

5.3 Student experiences

All students passed the course. For the construction management students, all students were international students and they found the experience of engaging with the industry particularly useful, as this was a further insight that they normally would not have had access to. Undertaking some primary research was also interesting for them, particularly compared to their peers who mostly used secondary data. They also found interacting with students from other disciplines useful as there were not too many opportunities for them to interact with students beyond their own disciplines in a study setting.

For the business students, their experience of engaging with the industry stakeholders, and particularly the construction management students were interesting. They were all local students and felt they had learnt more about acoustics, thermal comfort and daylighting from the construction students, as these students used instruments to measure these at set points in the building. For the computer science students, the experience was yet again slightly different. The students were postgraduate students, mix of international and local. Their engagement with the industry and other students was a very different experience compared to their other classes where technical work was the main focus. This course supported development of their softer skills.

The intent of the workshops during the semester with the students across the three disciplines and the teachers was to also support interaction between the students. This did not happen to the extent expected or desired. The interaction between the students of the various disciplines was limited. Unsurprisingly, students within the same schools interacted more with each other. While this was disappointing, the practicalities of timetabling, assessment scheduling and such other matters prevented students from engaging with each other beyond the requirements of the project.

5.4 Teacher and stakeholder experiences

As mentioned, teachers met several times throughout the semester to compare notes, discuss learning outcomes and discuss engagement with the various stakeholders. Not all the teachers were directly involved in interacting with the students. The project leader, also being an academic supervisor stayed in close contact with all the stakeholders. The computer science teacher was also the course coordinator and supervisor for the Master's students, so this teacher closely followed the innovation and student experiences in the course. For the business students, the teacher and the course coordinator were not the same as the business school typically has a large number of students in their classes. Therefore, getting both the course coordinator and teacher/tutor in the discussions was more difficult. It was felt that if support from senior executives such as the dean in the business school had been provided, the experience of the business students and staff would have been much stronger, contributing to a richer experience for all. To achieve better integration, getting buy-in from the staff would have supported better outcomes. A lot of time was also spent on ongoing engagement with the teachers from the three disciplines, contributing to workloads, not accounted for at the start of this project.

The industry stakeholders were very supportive. Despite busy schedules, they took the time and effort to work with the students, sometimes, even seeing students directly, without the presence of staff and guiding the students through industry-related knowledge. The architect, builder and project managers were particularly keen to understand how the spaces were used in the building. They were perhaps the cohort that got the most out of the process, as normally post-occupancy studies are not typically undertaken for buildings, even green buildings. The university property and facilities departments also learned a lot from the exercise as they were able to use this feedback to prepare better briefs for future buildings across various campuses of the university.

6. Conclusions

The research project set out to understand if a green building on campus may be used to engage students across various disciplines as well as support academic-industry engagement. The response to this is affirmative. The second question underpinning this research was to understand what, if any such innovation may influence built

environment education? The response to this second question is that, while it is not possible to generalise based on the one case study, nevertheless, there are some positive attributes of using campuses as urban learning labs for built environment students.

As a pilot project, the engagement of teachers and students in three disciplines, using a building on campus as a real-world example and engagement with industry was successful. Most spaces within the building reported satisfactory outcomes for students and staff. There were however further areas for improvement. Student engagement was successful, although it is difficult to discern if the use of a green building made any difference through the standard university course experience surveys. Staff were committed, and this commitment may be attributed to the success of the project. Time is a big factor in getting engagement between academic staff, students, industry stakeholders and the university facilities staff. Support is required centrally from the university if such projects are to be successful. Relationships between academic and non-academic staff need to be nurtured.

The systemic institutional integration of sustainability in existing and new programmes requires work and commitment from the leadership of the discipline at the university, particularly if the campus is to be treated as an urban living lab. If multi- or cross-disciplinary engagement is sought, it needs to be supported by an institutional commitment that influences all aspects of the institution. Such a holistic approach has the greatest potential to lead to change in students, teaching and non-teaching staff and the institution as a whole, including organisations that absorb graduates once they leave the comfort of the university environment.

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Conflict of interest

There is no conflict of interest.

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References

[1] Yin RK. Case Study Research Design and Methods. 5th ed. Thousand Oaks, CA: Sage; 2014

[2] Iyer-Raniga U. Integrating interdisciplinary thinking and practice: A case study of a Victorian university in Australia. In: Lamb M, editor. Proceedings of the 41st Australasian Universities Building Education Association Conference, AUBEA 2017; 3-5 July 2017; Melbourne, Australia: AUBEA. Melbourne: Proceedia. pp. 46-53

[3] UNEP and UNESCO. Tbilisi Declaration (1977) [Internet]. 1977. Available from: https://www.gdrc.org/uem/ee/tbilisi.html [Accessed: 28 September 2018]

[4] Knapp D. The thessaloniki declaration: A wake-up call for environmental education? The Journal of Environmental Education. 2010;**31**(3):32-39. DOI: 10.1080/00958960009598643

[5] Iyer-Raniga U. Resetting the compass: Principles for responsible urban built environment education. In: Filho WL, Rogers J, Iyer-Raniga U, editors. Sustainable Development Research in the Asia Pacific, Education, Cities, Infrastructure and Buildings. Swizterland: Springer Nature; 2018. pp. 31-77. DOI: 10.1007/978-3-319-73293-0

[6] Filho WL. Education for sustainable development in higher education: Reviewing needs. In: Filho W, editor. Transformative Approaches to Sustainable Development at Universities. New York: Springer; 2015. pp. 3-12. DOI: 10.1007/978-3-319-08837-2

[7] Filho WL, Shiel C, do Paço A. Integrative approaches to environmental sustainability at universities: An overview of challenges and priorities.

Journal of Integrative Environmental Sciences. 2015;**12**(1):1-14. DOI: 10.1080/1943815X.2014.988273

[8] Lozano R, Lozano FJ, Mulder K, Huisingh D, Waas T. Declarations for sustainability in higher education: Becoming better leaders, through addressing the university system. Journal of Cleaner Production. 2013;**48**(3-9):1-9

[9] Shiel C, Filho WL, do Paço A, Brandli L. Evaluating the engagement of universities in capacity building for sustainable development in local communities. Evaluation and Program Planning. 2016;**54**:123-134. DOI: 10.1016/j.evalprogplan.2015.07.006

[10] Velazquez L, Munguia N, Sanchez M. Deterring sustainability in higher education institutions: An appraisal of the factors which influence sustainability in higher education institutions. International Journal of Sustainability in Higher Education. 2015;**6**(4):383-391. DOI: 10.1108/14676370510623865

[11] Trencher G, Bai X, Evans J, McCormick K, Yarime M. University partnerships for co-designing and co-producing urban sustainability. Global Environmental Change. 2014;**28**:153-165. DOI: 10.1016/j.gloenvcha.2014.06.009

[12] Pereira G d SM, Jabbour C, de Oliveira SVWB, Teixeira AA. Greening the campus of a Brazilian university: Cultural challenges. International Journal of Sustainability in Higher Education. 2014;**15**(1):34-47. DOI: 10.1108/IJSHE-10-2011-0067

[13] Voytenko Y, McCormick K, Evans J, Schliwad S. Exploring urban living labs for sustainability and low carbon cities in Europe. Journal of Cleaner Production. 2016;**123**(1):45-54. DOI: 10.1016/j.jclepro.2015.08.053

[14] Riegler, J. Urban Living Labs in China? [Internet]. 2018. Available from: https://jpi-urbaneurope.eu/news/urban-living-labs-in-china/ [Accessed: 5 October 2018]

[15] Evans J, Jones R, Karvonen A, Millard L, Wendler J. Living labs and co-production: University campuses as platform for sustainability science. Environmental Sustainability. 2015;**16**:1-6. DOI: 10.1016/j.cosust.2015.06.005

[16] Barab SA, Landa A. Designing effective interdisciplinary anchors. Educational Leadership. 1997;**54**(6):52-55

[17] Müller-Christ G, Sterling S, van Dam-Mieras R, Adomßent M, Fischer D, Rieckmann M. The role of campus, curriculum, and community in higher education for sustainable development—A conference report. Journal of Cleaner Production. 2014;**62**:134-137

[18] Chambers D. Maximising sustainability outcomes by amalgamating dimensions of sustainability. In: Filho W, editor. Transformative Approaches to Sustainable Development at Universities. New York: Springer; 2015. pp. 195-206. DOI: 10.1007/978-3-319-08837-2

[19] Department of Employment, Australian Government. Work Trials and Work Experience [Internet]. 2017. Available from: https://docs.employment.gov.au/node/38196 [Accessed: 20 June 2017]

[20] Yocom K, Proksch G, Born B, Tyman SK. The built environments laboratory: An interdisciplinary framework for studio education in the planning and design disciplines. Journal for Education in the Built Environment. 2015;**7**(2):8-25. DOI: 10.11120/jebe.2012.07020008

[21] Posch A, Steiner G. Integrating research and teaching on innovation for sustainable development. International Journal of Sustainability in Higher Education. 2006;**7**(3):276-292. DOI: 10.1108/14676370610677847

[22] Callaghan R. Transforming teaching challenges into learning opportunities: Interdisciplinary reflective collaboration. Africa Education Review. 2015;**12**(4):599-617. DOI: 10.1080/18146627.2015.1112145

[23] Lid IM. Universal design and disability: An interdisciplinary perspective. Disability and Rehabilitation. 2014;**36**(16):1344-1349. DOI: 10.3109/09638288.2014.931472

[24] Kent J, Thompson S. Health and the built environment: Exploring foundations for a new interdisciplinary profession. Journal of Environmental and Public Health. 2012;**2012**:958175. DOI: 10.1155/2012/958175

[25] Nidumolu R, Prahalad CK, Rangaswami MR. Why Sustainability is Now the Key Driver of Innovation. Harvard Business Publishing; September 2009. pp. 57-64

[26] Barbieri CJ, de Vasconcelos IFG, Andreassi T, de Vasconcelos, FC. Innovation and sustainability: New models and propositions. Revista de Administração de Empresas. 2010;**50**(2). Abr/jun 2010, 146-154. ISSN 0034-7590

[27] Wood G, Wu S. Interdisciplinary studies in built environment education: A case study. IGI Global. 2010:316-334. DOI: 10.4018/978-1-61520-889-0.ch025

[28] Dima AM. Challenges and opportunities for innovation in teaching and learning in an interdisciplinary environment. IGI Global. 2013:347-365. DOI: 10.4018/978-1-4666-1969-2.ch017

[29] Pharo E, Davison A, McGregor H, Warr K, Brown P. Using communities of practice to enhance interdisciplinary teaching: Lessons from four Australian institutions. In: Higher Education Research & Development: Taylor and Francis; 2013

[30] Pharo EJ, Davison A, Warr K, Nursey-Bray M, Beswick K, Wapstra E, et al. Can teacher collaboration overcome barriers to interdisciplinary learning in a disciplinary university? A case study using climate change. Teaching in Higher Education: Taylor and Francis; 2012

[31] Wilson S, Zamberlan L. Show me yours: Developing a faculty wide interdisciplinary initiative in built environment higher education. Contemporary Issues in Education Research — Fourth Quarter. 2012;**5**(4):331-342, The Clute Institute http://www.cluteinstitute.com/

[32] Alagona PS, Gregory LS. The role of field study in humanistic and interdisciplinary environmental education. The Journal of Experimental Education. 2010;**32**(3):191-206

[33] Winter J, Cotton D. Making the hidden curriculum visible: Sustainability literacy in higher education. Environmental Education Research. 2012;**18**(6):783-796. DOI: 10.1080/13504622.2012.670207

[34] Painter-Morland M, Sabet E, Molthan-Hill P, Goworek H, de Leew S. Beyond the curriculum: Integrating sustainability into business schools. Journal of Business Ethics. 2016;**139**:737-754. DOI: 10.1007/s10551-015-2896-6

[35] Iyer-Raniga U, Moore T, Ridley I, Andamon MM. Reflections for sustainability: Capitalising on stakeholder on stakeholder engagement for optimising outcomes. In: 5th CIB International Conference on Smart and Sustainable Built Environment (SASBE); 09-11 December 2015; Pretoria: South Africa

[36] Iyer-Raniga U, Moore T, Kashyap K, Ridley I, Andamon MM. Beyond the building: Focusing on holistic sustainability outcomes for educational buildings. In: 15th International Australasian Campuses Towards Sustainability (ACTS) Refocus + Renew, 21-23 October 2015; Deakin University: Geelong Australia

[37] Moore T, Iyer-Raniga U. Reflections of a green university building: from design to occupation, Facilities. https://doi.org/10.1108/F-11-2017-0108

[38] Kashyap K, Iyer-Raniga U, Francis M. Showcasing 'real' green buildings: A case for post occupancy of university buildings. Zero Carbon Buildings Journal. 2017;**5**, CII, Hong Kong