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BEYOND CONSTRUCTION.....A CROSS-DISCIPLINARY APPROACH TO IMPROVED LEARNING AND TEACHING IN BUILT ENVIRONMENT DEGREES

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ABSTRACT

More than 3.4 million people die each year from water, sanitation and hygiene-related causes. Lack of access to clean water and sanitation kills those most vulnerable in the third world. Leadership in managing cross-disciplinary teams is required to present economical, viable community-based solutions. This project utilised the skills of undergraduates across different disciplines of construction, project management, engineering, design, and communication, to work alongside industry mentors in a team to design, build and present an innovative, sustainable water sanitation solution for a Bangladesh community. The semester-long project enabled undergraduate students to develop skills in client relationships, teamwork, and communication as well as discipline skills of project management and construction. The real-world problem necessitated a paradigm shift away from discipline-based knowledge transference towards skills for the future. The project utilised approaches such as negotiated curriculum and assessment; self-directed, flexible participation in learning; use of social media as a learning tool and cross-disciplinary teamwork. Results from student surveys and interviews indicate that this project directly enhanced students’ work-readiness skills and recognition of the importance of problem solving using cross-disciplinary understandings. Students reported greater self-confidence for tackling future workplace challenges. The results also illustrate strong levels of student satisfaction with the cross-disciplinary approach and the importance of skills in client relationships. The project and its outcomes have implications for how learning and teaching occurs in built environment disciplines and has the potential to create significant impact on the calibre of future built environment graduates.

Keywords: built environment, cross-disciplinary, work-readiness
**INTRODUCTION**

More than 3.4 million people die each year from water sanitation and hygiene-related causes. Nearly all deaths, 99 percent, occur in the developing world, with lack of access to clean water and sanitation killing those most vulnerable in their communities (Health Habitat, 2014). With 780 million people worldwide lacking access to an improved water source (or approximately one in nine people in the world), this is a pressing and complex global issue. Of critical importance is the need for emerging graduates to understand such global issues and problems and to practice, utilize and reflect upon the relevance of their skills in seeking solutions. Solutions to such issues require leadership, innovation, design and team approaches based upon strong cross-disciplinary skills.

Whilst Australian tertiary institutions list a range of skills as graduate attributes, there is often little evidence of the development of cross-disciplinary skills in tertiary courses in the built environment (Bridgstock, 2009). Yet the demand for a well qualified cross-disciplinary future workforce is increasing. The Organisation for Economic Co-operation and Development (2012) identifies the supply of skilled cross-disciplinary professionals, as an urgent global problem. This increasing global demand for “new” graduates with cross-disciplinary experience and knowledge is a result of a number of factors:

- the growing use and impact of information technologies inter-woven across all disciplines;
- the high rate of innovation fuelling rapid application of advances in cross-disciplinary products and processes;
- the growth in more complex global interacting problems (climate change, global security, environmental management, food and water supply etc); and
- the shift to more knowledge-intensive industries and services, not reliant upon single discipline responses.

**Literature Review**

Educational trends in learning and teaching of all tertiary disciplines focus upon the need for industry-related approaches to student learning, that maximise opportunities for future employment and lifelong learning (OECD, 2014). There is evidence that best practice approaches to learning and teaching ensure that students not only acquire knowledge, but also learn how to apply and adapt this knowledge to a variety of contexts (OCS, 2014). In parallel with this learning, students are expected to acquire generic skills of working in cross-disciplinary teams and projects. However built environment learning and teaching remains, for the most part, discipline-content entrenched. In many cases, built environment
courses are taught through discipline-based examples which are not reflective of real-life industry problems. In many cases, built environment disciplines are seen as opportunities to induct students into the content of the discipline, not as opportunities to develop cross-disciplinary skills or develop solutions to complex future problems. Many cross-disciplinary projects remain at the fringes of the curriculum, often in the “project, competition or challenge” arena, and are not capitalised upon at the institutional level or at the national level for the benefit of other tertiary built environment students and staff.

Increasingly the needs of employers and future global work opportunities do not recognise boundaries of discipline-specific education. Preparing students for new ways of dealing with growing bodies of knowledge that no longer fit neatly into a discipline programme creates enormous challenges for tertiary institutions organized along strict built environment discipline lines. Global industries require individuals with skills and knowledge across a range of disciplines. If teamwork is undertaken in built environment courses, it is often between other built environment students. Teams are rarely cross-disciplinary. Providing access to teamwork only between other built environment students and discipline-entrenched tertiary learning is limiting options for future graduates. Embedding cross-disciplinary approaches into core undergraduate built environment discipline curricula is for most universities unfamiliar territory.

Cross-disciplinary teaching can have a positive effect upon students’ achievement, satisfaction and employability (Pang & Good, 2000). There is also sound pedagogy behind cross-disciplinary courses, with advocates finding that such courses capture students’ intellectual interest (Lattuca et al. 2004), prepare students for work by developing higher-order cognitive skills (Kavanagh, 2011), and increase students’ tolerance for ambiguity, sensitivity to ethical issues, and creativity (Newell, 1994).

This paper examines the introduction of a cross-disciplinary course, the Water Innovation Challenge (WIC) Project Course, into the built environment discipline and other disciplines, at RMIT University in 2014/5.

**Research Method**

The Water Innovation Challenge Project Course created opportunities for staff and students from four different discipline-based RMIT schools to work alongside industry practitioners in a multi-skilled team to design, build and present innovative water sanitation solutions for a selected Bangladesh community. The project client responsible for the community selection and installation was Health Habitat, a global Non-Government Organisation operating across many third world countries. The project objectives were:
- To realise a viable water sanitation solution for a Bangladesh community

- To meet client needs in tender documentation (CAD, Budgeting, solutions etc), solution presentation etc and practical showcase to demonstrate the solutions.

- To showcase cross-disciplinary learning across a range of disciplines, including built environment.

The project course was conducted intensively over an eight week period in semester one. A total of 16 students were invited from science, engineering, built environment and health degrees and certificate 4 in plumbing services. Upon completion, students were awarded credit in their own programmes and, where necessary, engaged in negotiated assessments in their discipline degrees. A total of 16 students enrolled into the project course. Four of the students were selected from the total student group to present the final tender and sanitation solution to Health Habitat (the NGO client) in Singapore as part of a Worldskills Challenge event. Staff involved in the project course represented engineering, health, construction/project management, plumbing, media and IT disciplines. Staff and students were given a brief and information by the client. They worked in one large team with needs-based sub-groups formed and reformed as the project progressed.

The project course capitalised upon the RMIT tertiary advantage of being a multi-sector institution with students and staff from VE and HE working alongside each other. The project course required new approaches to learning and teaching and student engagement, moving away from discipline-based content and learning to cross-disciplinary problem solving. These approaches were based upon current models of pedagogy and problem-based learning (Kuenzi, 2008; Rice, 2011; Devlin & O’Shea, 2012).

Scheduled sessions were organised around themes of the project (local resources, CAD, public health, costings etc) and students worked together in a cross-disciplinary group. Session times were flexible. Smaller teams/subsets of the project team were formed, reformed and disbanded as the project scope demanded. Although a formal class time and place once a week was set, attendance was not compulsory. There was flexible participation in the learning with new staff and post-graduate students joining the group as skill needs dictated e.g. editors, writers, cartoonist, CAD operators.

Social media was used as a communication and document control tool. A Google site, Facebook page and drop box were used as a virtual “meeting place” and “exchange“. Evaluation and feedback was built into the learning process, with set time devoted each week to evaluation of the
design and development processes. This opportunity for reflective practice enabled students to scaffold their learning each week and focus upon emerging barriers to completion.

Milestones were created by the group. These milestones formed the assessment for the courses, with reflective journals and final documentation/solution to client, forming most of the assessment. Academic staff acted as a resource and organised industry speakers and other sources of information. Students worked on self-arranged themes and met with the client a number of times (including skype) over the semester. All students completed the tender to presentation stage. Four of the students were selected from the total group to present the final tender and sanitation solution to the client, Health Habitat.

Students’ negotiated credit and assessment in their own discipline programmes based upon their contribution to the project. This concept of negotiated assessment guides students in their learning and allows them to exhibit control of their learning programme. This negotiated assessment was aided by staff interventions where necessary.

All students from each discipline were able to participate, and learning and teaching practices were deliberately inclusive to enable full participation. Students involved in the WIC Project came from diverse backgrounds with differing levels of knowledge, skills and abilities. The organisation of the project allowed all students to participate in the team work. Staff mentoring assisted all students in achieving outcomes. Inclusive practices included mentoring, virtual support and peer mentoring.

**Results and Discussion**

Students in this project were surveyed and a smaller number (6) participated in semi-structured interviews asking them to elaborate on the survey questions. The collection of this data took place at the end of the semester. Their interview responses and their answers to the written survey were recorded. Table 1 (below) shows a summary of the survey responses.
Table 1: Student responses to survey questions

<table>
<thead>
<tr>
<th>Survey Question</th>
<th>Yes</th>
<th>No</th>
<th>Don’t Know</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did you like working with students from different disciplines and levels of study?</td>
<td>95%</td>
<td>0%</td>
<td>5%</td>
</tr>
<tr>
<td>Did you think that this project has prepared you for work once you graduate?</td>
<td>85%</td>
<td>0%</td>
<td>15%</td>
</tr>
<tr>
<td>Would you undertake similar types of cross-disciplinary projects/courses in the future?</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

*(response rate: 67%; n=13)

These results indicate the success of the cross-disciplinary project course. This project was distinctively innovative in the development of built environment graduates for the future. The first distinction lies in bringing together a cross-disciplinary cohort from a range of disciplines to examine the problem from new perspectives, to value the skills of others and to utilise the learning of others in solving new problems. As identified earlier in the paper, the critical need for tertiary students to work in cross-disciplinary teams and explore the interconnection between future skills and knowledge requirements of industry must be enhanced (Lyons, Quinn, 2014). In this project course students were provided with this opportunity. As one student responded:

“It allowed me to develop and work in an environment that would reflect the real world and I have learnt so much about working with others in a team project.”

In the student surveys when asked “Did you like working with students from different disciplines and levels of study?” 95% of the respondents said that they liked working with students from different disciplines. This satisfaction level mirrors earlier findings by researchers into the value of integrated approaches in teaching cross-disciplinary courses (Pang & Good, 2000; Kavanagh, 2011). This understanding of the need for new knowledge and cross-disciplinary team approaches was readily embraced by nearly all the students:
“The team itself included individuals of diverse experience and background. This provided a simulation of how engineering problems are faced in the real world. The experience was invaluable.”

Another student commented that:

“A variety of different knowledge backgrounds allowed the team to understand situations from different perspectives.”

This was further evidenced by their comments upon their learning:

“I like to learn from people from other fields to expand my knowledge and maybe change my view of things.”

Another student responded with,

“It’s much more closely aligned to how industry operates, which is something that is not often addressed in normal studies.”

However not all students were comfortable with being in a cross-disciplinary team with 5% responding negatively to the question of working in cross-disciplinary teams. There are challenges to this type of pedagogy. These include creating a suitable learning environment, differences in discipline approaches to problem-solving, different levels of commencing knowledge and communication across the team. Some students described how working in a cross-disciplinary team was a personal challenge, and they felt uncomfortable with the learning approach. Student comments outline these challenges:

"It was OK but it was hard co-ordinating people from different courses, and I didn’t like it."

And: "It took me by surprise. A lot of it was left up to us to understand....we had to make sense of what was happening."

This “uncomfortableness” with the learning approach and the challenge of cross-disciplinary team members, is one that can be overcome, as students grow towards an understanding of their role in a cross-disciplinary team and their ability to contribute. As Kavanagh & Cokley (2011) note, the communication of potential hurdles and team challenges can solve much initial student wariness, but the importance of acquiring new skills in cross-disciplinary understandings should not be negated by such challenges.

Through this real-world water sanitation problem, the students were able to access, filter and critically engage with new knowledge and new ways of knowing. When surveyed with the question: Did you think that this course has prepared you for work once you graduate, 85% of the
students believed that the course had prepared them for work upon graduation. Students commented that:

“It showed me how to work effectively in a team for a real-world project”

“It was a steep learning curve for me- not all are from my field, so I didn’t know how to deal with that at first, but in the end I was really confident working & leading.”

Other students demonstrated their desire to “extend themselves beyond their comfort zone” and place themselves in situations where they were “forced” to lead:

“This project has really prepared me for work. I had to exhibit leadership, time management skills and most of all, incorporate client requirements into our design”

The project course also directly enhanced the student experience and their overall engagement. This was evidenced by their comments upon completion:

“This was an awesome learning experience”

“I have learnt so much about working with others in a team project with real deadlines”

In this project the built environment academic staff engaged with the students as professional peers, collaborating on activities. This is in contrast to approaches in other courses which are traditionally seen as opportunities to induct students into the content of the discipline, not as opportunities to develop solutions to complex cross-disciplinary problems (Rice, 2011). In this project, the collaboration was not “teaching” but more closely resembled a face-to-face dialogue between two sets of learners each prepared to teach the other something new. This approach resulted in built environment staff and students at all stages of experience and knowledge entering ‘into a co-learning relationship guided by action and reflection’ (Huesca, 2003). One student commented:

“It was certainly different, and effective, we always discuss ideas and share knowledge with others, even staff!”

A final difference was that the challenges were real global issues, along with the client. The purpose and objectives of the project were clear to all and students involved. The students noted this understanding of purpose, illustrating their understanding and knowledge of the design/tender/presentation processes involved in real-world projects:
“One of the most significant opportunities that this course has given me to this point is the chance to use my skills learnt thus far in designing and implementing a solution to a real-world problem in a disadvantaged community. Most employers require the demonstration of working in teams. The exposure to a variety of disciplines and skill levels is much more reflective of the workplace and as such I feel it was highly valuable.”

This project was unique in that it addressed a critical need in built environment education: cross-disciplinary team work. Students were aware of the value of the project course:

“This project has really prepared me for work. I had to exhibit leadership, time management skills and most of all, incorporate client requirements into our design”

The project course has resulted in significant impacts within the university, the sector and the government. It has been a true demonstration of RMIT’s strategic plan of being a tertiary institution that is "urban, global and connected." (RMIT, 2011 – 2015). Over 60 students from health, engineering, science, construction management and VE associate degrees have applied to be involved in the next semester project. New staff will be involved in the next semester project course, including two early career academic staff. Students and staff made a presentation at the Singapore Water Innovation Conference and Expo 2014 and the staff involved were awarded an innovation teaching award at RMIT university in 2015.

Much of current discipline-entrenched built environment learning and teaching has not equipped tertiary students to adequately tackle problems requiring cross-disciplinary solutions. All of the students, both in the surveys and the interviews, noted their lack of discipline preparation in working in a cross-disciplinary team and their lack of ability to move beyond their discipline boundaries to solve problems and to apply knowledge in new ways. They indicated that their discipline group work had not prepared them well for the challenges of working with people from diverse industries. However all of the students surveyed enjoyed the project course as an engaging experience and over three-quarters of them felt they learnt more through involvement with other disciplines. Of concern was the fact that all of the students involved in this project course felt that cross-disciplinary work for real clients was unique in their education to date in the university. The skills gained through cross-disciplinary teamwork and meeting real client deadlines and expectations were the most obvious of skills and knowledge identified by the students.

As with all action research studies there are limitations to the results. Firstly, this research has only examined the outcomes from the project course at one university. In addition, the sample sizes in this project
course was very small due to the nature of both the project and the rigidity of built environment curricula. The project course was an elective for discipline students, so the cohort did consist of a large number of students who had elected to be there. Participating students may not be representative of students in other educational institutions. Consequently, generalising findings to other student groups should be done cautiously.

A second limitation relates to the duration of the projects, as well as to students’ overall experience as learners in a higher education setting. Whilst there were some final year students involved, there were also a number of first year students. When the students were surveyed and asked if they felt they had learnt valuable work skills for the future, 15% of them were undecided and responded “don’t know” to the survey question. Those who clarified their response typically said that it was too early in their university programme to have a sense of graduation benefits. For example one student commented that:

“It has definitely been beneficial in simulating real-world experiences, however first year is a little too soon to tell.”

Finally the sustainability of such learning is the challenge for built environment cross-disciplinary approaches. There is a need for senior leadership to provide greater cross-discipline co-operation and recognition and support of these approaches in tertiary institutions. The irony is that for many of the students involved in this project, they already understand this need, with 81% of them responding positively to the question of future cross-disciplinary study. As one student summed it up: “I would take classes like this again because it is so interesting and useful for the future.”

It is the very limitations discussed above that may provide avenues for future research such as the broader involvement of wider ranges of disciplines, the broadening of the student diversity and the embedding or sustainability of these project courses over time. Finally there may be opportunities to explore future employment patterns of students undertaking cross-disciplinary built environment courses and their career pathways. Such research would provide valuable windows into the role of cross-disciplinary learning in career aspirations of built environment graduates.

Conclusions

This project involved only a small number of students and staff from the lead university- this is an obvious limitation. However, it is evident from this small study that student skills in cross-disciplinary teamwork, communication and problem-solving can be developed and nurtured. There is also evidence that students were more engaged and motivated in cross-disciplinary learning activities.
Expanding student options and providing work-relevant cross-disciplinary learning and teaching in built environment degrees is fundamental to meeting Australia’s future needs, as well as providing social and individual satisfaction. The development of capacity and senior leadership that nurtures and creates collaboration across disciplines and fosters and grows confidence amongst academic staff in promoting these cross-disciplinary projects and curricula is also required for the sustainability of these approaches. There is an urgent need to develop undergraduate skills in applying the interconnectedness of knowledge across disciplines. Doing this will necessitate a change of thinking about the value and curriculum place of cross-disciplinary, global approaches to learning and teaching in built environment disciplines.

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