AAEE2016 CONFERENCE
Coffs Harbour, Australia

Student response to a technology enhanced learning space

Surendra Shrestha, Harry Wang and Carol Russell
Western Sydney University
Corresponding Author Email: s.shrestha@westernsydney.edu.au

CONTEXT
A collaborative learning space (CLS) replaces traditional lecture theatres and tutorial rooms. These spaces complement a flipped classroom model by providing better opportunities to share the information individual students have collected outside the classroom. When supported by appropriate technology, these rooms allow for more authentic forms of classroom learning activity than traditional lecture and tutorial sessions.

PURPOSE
The purpose of this paper is to evaluate the affordances of a prototype technology enhanced CLS in terms of the experience of a cohort of third year engineering students. The classroom activities were designed to correspond better with real engineering work environments than the lectures and tutorials that previously accompanied the project work.

APPROACH
Students worked as teams to solve an authentic real world project in a classroom setting. The classroom itself was a CLS that used the state-of-the-art technology. The students were guided during each workshop session, as they might be by a team leader in a work environment, supported by the latest technology.

The students were asked to provide in-semester and end-of-semester feedback explaining their experience of the CLS in their learning. They were encouraged to point out both the good aspects of the space as well as what can be improved to achieve better learning outcomes.

RESULTS
The CLS proved to be popular with the students and resulted in better engaged sessions, and thereafter, better academic results. In-semester feedback suggested that the students were enjoying the new learning environment. The end-of-semester analysis and student performance reinforced this finding.

CONCLUSIONS
The technology enhanced CLS resulted in better learning outcomes, principally through enabling a more authentic form of student engagement.

KEYWORDS
flipped classroom, collaborative learning space, student experience, student-centred.

Introduction

Over the past two decades, the physical environment where learning takes place has been a growing area of academic interest in higher education (Wood, Warwick, & Cox, 2012). Colleges and universities have devoted substantial resources to the research and development of technology enhanced learning spaces. Compared with what learners can achieve in traditional teacher-centred classrooms, these newly developed and technology-enhanced learning spaces focus on learning activities that are student-centred. More importantly, the learning occurs through collaboration among learners themselves (Beichner, 2014).

In 2012, Western Sydney University (the University) began an ambitious journey of developing a 'student-centred' institution of higher learning. Curriculum innovation that provided flexibility and learning environment supported by the state-of-the-art technology formed central part of this process. The latest Learning Futures Plan 2016–2020 (LFP) of the university (University, 2016b) continues this journey by taking additional steps in its next phase of learning transformation. The LFP places students at the centre of learning and teaching (L&T), supported by innovative learning designs, experiences, environments and enablers. As specifically defined in the LFP, "*student centred learning environments are being designed and built to embody the contemporary qualities of the world that teachers and students live and work in. These environments will be technology-enabled, participant-shaped, industry engaged and increasingly, industry and community co-located*".

Guided by the LFP, construction work is currently underway to develop the University's new flagship campus at One Parramatta Square (1PSQ). The L&T activities are scheduled to begin on this new campus in Autumn 2017. All classrooms in the building have been designed as collaborative learning spaces (CLS) that cater for different forms of learning interactions including, but not limited to,

a) contribute and compare,
b) group work,
c) present and discuss,
d) highlight and share peer work, and
e) remote collaboration.

In the context of engineering education, Johri and Olds (2011) examine some underlying learning theories that explain how learning media and spaces shape the character of learning as a 'socio-material' process. In particular (Table 2) they note that because "*engineering work is usually project-based, accomplished by teams, and is highly collaborative*", engineering education should incorporate teamwork and collaboration.

In Autumn 2016, The University built two prototype CLSs on two of its existing campuses to test suitability and effectiveness of the technology in these spaces. One of these spaces was used in an engineering subject during the semester. The subject chosen was a core third year civil engineering subject in which students traditionally struggled. The L&T interactions adopted in this subject aligned with interaction forms (b), (c) and (d) in the list above. This paper presents an analysis of the effectiveness of the adopted approach in achieving the subject learning outcomes, as evidenced through student performance in the subject. Student perceptions on the CLS have been gauged using the comments received throughout the semester.

Collaborative Learning Space (CLS)

Traditional L&T spaces in higher education consist of large lecture theatres and smaller tutorial rooms. Lecture theatres are typically used to disseminate information to large student cohorts whereas smaller tutorial sessions are used for more interactive relatively smaller sessions. While this model has proven useful in the past, current students have

different expectations and are increasingly disengaged with these types of learning spaces and activities. The rapid advancement in digital technology and easy access to information seem to have exacerbated the perception that traditional lecture and tutorial style learning spaces are old fashioned and neither meet today's students' needs, nor correspond to current professional practice (Friedman, Friedman, & Frankel, 2016).

This recognition led to the University's ambitious plan of developing and implementing flexible and innovative curriculum, using L&T spaces that cater for collaborative and more active learning styles. The new building at the centre of Parramatta Central Business District (CBD) provided the perfect opportunity to take the University's technology enhanced CLS to another level. As claimed by the vice Chancellor of the University, the collaborative learning spaces have been designed to provide

> "… *one of the country's most technologically-advanced learning environments – one that is highly interactive, and which uses personalised technologies and approaches to significantly enhance the student experience"* (University, 2016a).

Design and configuration of CLS

To ensure that the CLS designed and constructed meet its objectives, two prototype rooms were constructed, as trial rooms, in two different campuses of the University. As can be seen from Figure 1, which shows the layout of the prototype room, the room has been designed to facilitate interactive work among small groups. The room consists of ten D-shaped tables with monitors (Computer on Wheels - CoW) and can accommodate up to six students each. The pedagogical strategy behind this layout is to optimise learning through collaboration where students become the centre of their own learning. The arrangement allows for the students to share their ideas and experiences (i.e. via research work, offline/online collaboration, field visits, work experience, etc.). The academic's role changes from that of a teacher to that of a facilitator. S/he is available principally to facilitate collaboration through a wide range of carefully designed and technology-enabled learning activities, in which students are sharing, engaging, applying, integrating and developing their knowledge interactively and socially – with peers as much as with the academic.

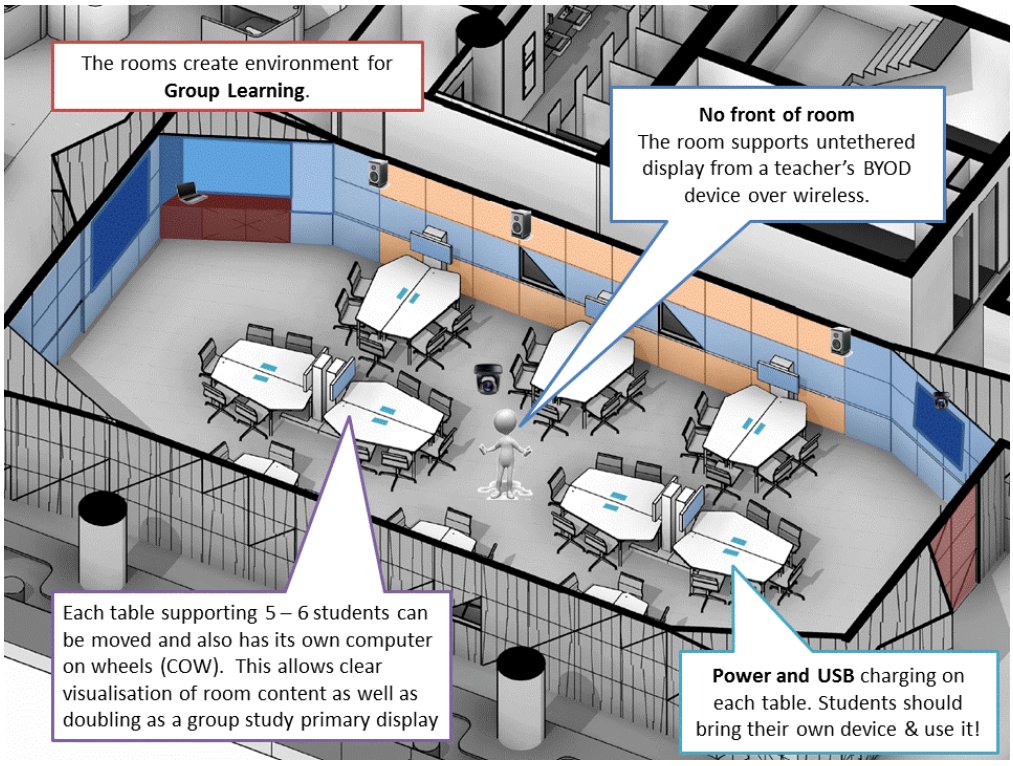

Figure 1: Collaborative Learning Space

Table 1 summarises the technical features of the prototype room with a short description of each feature.

Table 1: Features provided in the CLS prototype room

Feature	Description
Lectern	A 'presentation station' is tucked away in one corner of the room. This station swings out, when needed, to enable students and academics to operate a plugged in device or PC without turning away from the class. From the presentation station, a presenter can prepare content for sharing onto the primary screens from the following resources: one's own mobile devices, lectern PC, document camera, whiteboard camera, and/or wired inputs (VGA/HDMI/USB).
Computers on wheels (CoWs)	At each group table, there is a computer on wheels (CoW) for one student from each group to login using a wireless keypad (a combination of a keyboard and touch-pad). Except for the big screen to optimise viewing, the CoW works like a normal PC and it enables all students sitting around the table to work together on various learning activities. Students can also choose to use third party applications and all students in the group can contribute simultaneously from their own devices, while the main screen can be used to display the outcomes.
Audio system in the room	Discrete microphones are located on the ceiling around the room to pick up audio across the learning studio. A lapel microphone is available to help maximise volume. It is especially useful for video conferencing sessions. Headsets are also available for hearing impaired students.
Whiteboard and whiteboard camera	Magnetic whiteboards are located around the walls in the prototype room. Students and academics can use them to share and discuss ideas by drawing/writing on the whiteboards or by simply sticking pieces of papers. The whiteboard camera installed on the ceiling in the middle of the room can be used to capture the content on the whiteboards and share with the rest of the class. There are buttons on the walls to switch whiteboard camera views. Students sitting at the tables can view the content on their CoW screens.
Document camera	A document camera is available on the lectern for sharing hardcopy contents. The document camera can also take snapshots or videos of the shared content. Students sitting around the tables can view the content on their CoW screens.
Solstice	With the Solstice-enabled display in the room, any number of users can instantly connect, share and control the display, fostering collaboration and decision-making. Students in the CLS prototype room can use Solstice to share content from a wide range of sources with the rest of the class. Students sitting at different tables can view the content on their own CoW screens.
Zoom	Utilizing Zoom in the prototype room not only provides a backup sharing solution in addition to Solstice, it also helps connect other remote experts or learners to the prototype room. A Zoom session can be set up from the lectern PC. The camera installed at the end of the room can also be used to capture the room view and share with remote users.

Design and implementation of learning activities

The activities throughout the 2016 autumn semester were designed around a project in which students worked in teams to develop a flood mitigation plan for a land development project on a (real) site. Instead of the traditional weekly lectures and tutorials, several full-day workshop sessions were conducted at regular intervals throughout the semester; more closely simulating professional team reporting and reflecting in various sessions during an

engineering design project. In terms of the project types identified by Gómez Puente, van Eijck, and Jochems (2013, p. Tables 2 and 5), this would be characterised as an 'authentic/real-life scenario' example of design-based learning, using 'peer learning processes within and across teams'. During the first workshop, the 95 students formed themselves into 26 teams that would work on the project together and attend the same workshop sessions throughout the semester.

The learning design made use of several types of interactions supported by technical features in the prototype room. To support this, learning materials were developed to fit a hybrid model - flipped classroom (FC) approach in a Project-Based Learning (PBL) subject. Supplementary material in the form of PowerPoint files and recorded and sourced short video clips were provided – pre-class and post-class activities were designed around these supplementary materials.

Because the equipment was new, a significant proportion of the first workshop session was devoted to familiarising the students with the new learning space and the technology in the room. An IT expert, who was closely involved in the design and implementation of the technology in the room, was invited to introduce and demonstrate all technical features of the prototype room. The first workshop session was also used to form teams and discuss the scope of the projects assigned.

Students were required to review the online materials and complete pre-workshop activities before attending each workshop session. In the workshop sessions, students worked as teams to explore potential solutions to their assigned project, under the supervision and guidance of two facilitators (academics). Each team was required to present their progress to the class during the semester. The last workshop session was used to share each team's solutions to their [real-life] projects and share their experiences. Each team also prepared and submitted a technical report, which was used as a part of the final assessment.

Each workshop began with the senior facilitator leading a review of the pre-class tasks (*contribute and compare*). The students worked on their teams to solve parts of the assigned project (*group work*) – the facilitator used 'teachable moments' to interject competencies required to solve the project. Each team made a 10-minute presentation to the rest of the class at some point during the workshop about their project (*present and discuss*). Each team also made a brief presentation during the final workshop session (*highlight and share*) – this presentation was to present the proposed solutions to the assigned project; team members were also encouraged to reflect upon their experiences.

The teaching team applied various L&T activities repeatedly and selectively throughout the semester. Some of the strategies used were – (a) the 'jigsaw activity' described by Aronson (2010), (b) the 'role playing' described by Bartz and Deaton (1996) & Ponsa, Vilanova, and Amante (2010) and (c) the 'one minute paper' strategy of Stead (2005).

Each team member was required to make on-line journal entry (entries) each week. The requirement was to list what they had learnt during the week – both inside and outside the classroom. They were also encouraged to write a brief reflection on their experience of the CLS. This reflective journal was available only to the individual student and the facilitator.

Data collection, analysis and results

The evaluation data came from three sources, all of which had ethics approval for use in this study. A random selection of 25 student journal entries made throughout the semester was analysed. Also, the students were continually encouraged to send e-mails to the subject coordinator describing their experiences of the learning space – both in terms of the layout of the space and the technology available in the room.

At the end of the semester there is a standard student feedback process for every subject. This includes open-ended comments on the 'best aspects' and 'what could be improved'. These text comments were analysed to derive emergent themes. The thematic analysis

covered the design of the learning activities as well as the student response to the learning space and is outlined in more detail in Jones and Shrestha (2016). Here we present a summary of the results related to the use of the CLS, in terms of student engagement and student performance, with some illustrative examples of student feedback.

Student engagement

Workshop attendance and participation as well as frequency of journal entries were used as indicators of student engagement in the unit. Three of the 95 students enrolled in the subject did not attend 69% of the classes. Attendance for the remaining 92 students was 100% throughout the semester (highly unusual for a senior level engineering subject). The facilitators observed the students engaged and busy during workshop sessions – the constant discussions during the sessions were clear indication of student engagement. While student engagement was influenced by the design of the activities as well as the CLS, the results of the detailed analysis of end-of-semester feedback (48% response rate) suggest that the new learning environment made a significant contribution. Details are presented in Jones and Shrestha (2016).

Student performance

Student learning was gauged through student performance in the subject in comparison with previous students who were assessed for the same learning outcomes, using similar criteria and standards-based grading. The grade distribution of the cohort indicates that the peer support available within and outside the workshop sessions helped the academically weaker students. This was also evidenced through a number of comments in the end-of-semester feedback. One student wrote, "*The ability to work as a part of a team to work through and solve problems relating to the project*" was one of the best aspects of the approach adopted in the subject. The grade distribution also shows a higher proportion of students receiving Distinction (D) and High Distinction (HD) grades (detailed analysis is presented in a companion paper in this conference). This is an indication that good students performed better (Shrestha, 2016).

One of the most interesting and encouraging results was the performance of the cohort – every student who remained enrolled in the subject achieved the learning outcomes of the subject; this is in sharp contrast to previous offerings of the subject (Shrestha, 2016) – as stated earlier, this was a challenging subject. Part of this success must be attributed to the design and effective use of the CLS.

Student feedback

Students enrolled in the subject were asked to provide regular feedback throughout the semester. The students were asked to e-mail their experiences with the new learning style as well as the learning environment. A majority of the responses indicated that the students enjoyed the learning environment. One response at the beginning of the semester stated,

> "*The opportunity to be the first class to use the Prototype Room is one that seems interesting, along with the project to be completed in a "real world" type environment is one that I am very much looking forward to*."

Student experience with the room and the technology continue to be positive as the semester progressed. One student wrote, "*The room that has been set up is very helpful*" while another student stated, "*I am finding the room to enhance student collaboration*." Yet another student sent the following comment about the room and the technology available in the room,

> *"I liked how the room was designed to satisfy the purpose of team working as the tables were set up nicely and the computer on the tables were really fun as it had the new tools where you can see what the people share with you."*

Almost all the negative comments were related to wireless connectivity in the room. One student commented, "*the only complaint … I have is that of the Wi-Fi … connectivity … in the new room*".

Conclusions

Student feedback and academic performance indicate that the technology-enhanced CLS was an essential component in an authentic learning design that improved learning outcomes. It is important to recognise that effective use of the CLS also requires the other components of the students' learning experience to be in alignment. The teaching staff need to be well versed and fluent in using the technology available in the room; otherwise this can become overwhelming and distracting. The teaching team also need to ensure that their delivery methods are pedagogically driven rather than technology driven. Students need to be prepared for the technologies in the room, as well as be open to the new delivery model supported by the new technologies. Last but not least, the unit needs to be carefully designed to cater for efficient delivery using meaningful assessment strategies. Students, who are used to the traditional delivery model will need to be informed and reassured throughout the semester, so that they are comfortable with the learning environment and can embrace the benefits it brings to their learning.

This empirical study has shown how a state-of-the-art technology-enhanced CLS, despite some technical glitches that are inevitable in a prototype, can contribute to an authentic and effective socio-material learning process.

References

Aronson, E. (2010). *Cooperation in the classroom: The jigsaw method*: Pinter & Martin Limited.

Bartz, M., & Deaton, R. J. (1996). Role playing in engineering education. *age, 1*, 1.

Beichner, R. J. (2014). History and evolution of active learning spaces. *New Directions for Teaching and Learning, 2014*(137), 9-16.

Friedman, L. W., Friedman, H. H., & Frankel, M. (2016). A New Mode of Learning in Higher Education: The Partnership Hybrid Class. *Available at SSRN*.

Gómez Puente, S. M., van Eijck, M., & Jochems, W. (2013). A sampled literature review of design-based learning approaches: a search for key characteristics. *International Journal of Technology and Design Education, 23*(3), 717-732. doi:10.1007/s10798-012-9212-x

Johri, A., & Olds, B. M. (2011). Situated engineering learning: Bridging engineering education research and the learning sciences. *Journal of Engineering Education, 100*(1), 151-185.

Jones, L., & Shrestha, S. (2016). *Use of Flipped Classroom Approach in Project Based Learning: Student Perspective.* Paper presented at the International Conference on Engineering Education & Research, 21-24 Nov 2016, Western Sydney University.

Ponsa, P., Vilanova, R., & Amante, B. (2010). *The use of role playing in engineering curricula: a case study in human-automation systems.* Paper presented at the IEEE EDUCON 2010 Conference.

Shrestha, S. (2016). *Flipped classrooom and project based learning*. Paper presented at the AAEE2016 Conference, Coffs Harbour.

Stead, D. R. (2005). A review of the one-minute paper. *Active learning in higher education, 6*(2), 118-131.

University, W. S. (2016a). Construction high point reached on University's new Parramatta City campus. Retrieved from http://www.westernsydney.edu.au/newscentre/news_centre/more_news_stories/construction_high_point_reached_on_universitys_new_parramatta_city_campus

University, W. S. (2016b). *Learning Futures Plan 2016-2020*. Retrieved from http://www.westernsydney.edu.au/__data/assets/pdf_file/0004/1095034/Learning_Futures_Plan_2016-2020.pdf

Wood, P., Warwick, P., & Cox, D. (2012). Developing learning spaces in higher education: an evaluation of experimental spaces at the University of Leicester. *Learning and Teaching, 5*(2), 49-72.

Acknowledgements

The authors acknowledges the Central Blended Learning team at Western Sydney University for their support in unit design and delivery, as well as their contribution in providing staff professional development and student briefing sessions. The authors also acknowledge the feedback the students provided throughout the semester.