Full Paper

Background or Context

With the re-imagining of engineering education at Deakin University an opportunity was presented with the ability to design purpose built spaces. With this development a review of leading practice educational spaces was undertaken specifically in a product development, mechatronics and a materials unit. Whilst these areas have different needs there were some common elements with the location of teaching aids, apparatus and experimental set-up and collaborative teaching spaces.

Purpose or Goal

This study examined what would a best practice learning environment look like in different disciplines and what is the connection and similarities in a problem based learning environment. A benchmarking study and literature review on best practice was undertaken; this learning space was intrinsically linked to the educational model. Aspects of the educational model have started to be implemented in this long term project

Approach

Student perceptions were measured primarily through standard unit feedback, targeted surveys for all units as well as student comments on the units. Engagement of students was the primary focus of the redesign of purpose built spaces as well as curriculum review. By placing students into specifically designed spaces to enhance learning outcomes it is anticipated that the knowledge and skills attainment will be higher for all students.

Discussion

The redevelopment of learning spaces has forced staff to think hard about their units and how space impacts on student educations. With the engineering units, student had the ability to move through spaces depending on what they were doing. This ability to move is a combination of the educational model, the facilities and staff/student interaction.

Conclusion

While part of a long term redevelopment of facilities and curriculum, it has been found that when the facilities match the educational model student acceptance seems to yield positive outcomes, however, further work needs to be done. This has been support in both the literature and observation through student and staff evaluations of the unit. It is expected that as students adapt to the new educational model further they will make greater use of the purpose built facilities.

Background

Deakin University's School of Engineering has undergone significant change in the previous 12 months. Students and staff are transitioning from a predominantly classical based engineering study programme to a more Design Based Learning (DBL) environment; part of this change included the construction of a new building and the development and implementation of new learning spaces. Several studies suggest that learning spaces have just as much effect on learning as does the delivery of the content. Doorley and Witthoft (2012) state that delivery and space cannot be separated and that movement and ownership of space is critical to student learning. DBL environments have been used and studied in a variety of settings and programmes such as medicine, visual and creative arts, each of these disciplines of study have their own unique settings in which students take ownership of the space, whether for a week, a semester or an entire course.

Before the development of the space commenced, studies were undertaken to look at best practice environments from other institutions such as Stanford University (Dym et al, 2005), University of Coventry and National University of Singapore (NUS, 2015) as well as our own learning in previous iteration of the Deakin Engineering course (Joordens, 2012 and Joordens et al, 2012). For example ME310 a DBL based subject on product development at Stanford University gives students a dedicated space to learn, develop, prototype and interact for an entire year. Students take ownership of the space; bring in their own technology and resources as needed and have access 24/7.

In trimester two, 2015 at Deakin, four units were run in DBL format within the new learning environment. The units were all third or fourth level and represented three disciples of study; SEM313 – Manufacturing and SED402 – Advanced Design Methodologies from the mechanical discipline; SEE326 – Artificial Intelligence for Autonomous Systems from mechatronics discipline and SEV353 – Reinforced Concrete Structures from civil. For each of the disciplines the students have had limited interaction with DBL learning environments in the earlier years of their engineering studies. This allows a unique opportunity to gather students initial perceptions of the impact the new environment has on their learning and on our teaching styles.

Purpose

The main goal of this study was to measure the level of acceptance to the learning environment. The creation of any new learning environment takes considerable resources and once developed it is incredibly hard to change, while the curriculum and use of the learning environment is somewhat easier to change in response to student needs. The delivery of DBL to four key units was part of a preliminary trial of the new building and learning spaces prior to full roll out to the entire programme in 2016. The use of a select number of units allowed academic staff to trial teaching and learning concepts in a lower risk environment with senior students. All four units have been run in a project based learning style during previous offerings, and hence, they were less likely to run into issues that could mask the impact of the learning spaces on the students.

Design / Methodology

General Learning Environment

The standard layout of the DBL rooms throughout the new Engineering building at Deakin are six triangular shaped tables with six seats at each table. The audio-visual equipment (AV) is spaced around the room, with two large touchscreens TVs at the front of the room and six smaller touchscreens placed around the room (each one in close proximity to one of the triangular tables). Each TV screen is independently controlled, and can be used either via touchscreen controls, or they can be connected to wirelessly and used essentially as a display for any device in the room.

The DBL rooms are co-located to teaching laboratories so students have the ability to move from one learning environment to the next as required. The co-located spaces include areas such as materials testing and characterisation facilities, design and prototyping facilities or mechatronics fabrication facilities.

Further to the DBL rooms and teaching laboratories, there is a range of open spaces, informal study zones and user configurable spaces that student and staff can use to best suit their purposes within the new building. The building does not contain any computer labs as the new programme has been designed with a Bring Your Own Device (BYOD) policy. The BYOD concept was brought into effect to increase mobility and choice for the students to not only pick their own hardware but to also the flexibility to study in their location.

The learning environment has been designed to suit multiple modes of delivery to reflect the fact that each teaching academic often have their own culture of DBL.

SED402 – Advanced Design Methodologies

The unit revolves around a single narrative of a product development challenge. Students are asked to go through the entire process of customer investigation, technology investigation, prototype and testing to develop a product based around a key theme/s.

Students spend about 20% of their class time discussing and debating general design and product development concepts, the rest of the time students work with their teams to design, research and develop their own specific products.

The students have the ability to move through-out several spaces depending on the stage and type of their product. For the majority of class discussions it happened in a collaborative learning space where six student each facing each other and six tables in the room. There are multiple screens around the room where the lecturer and students can show work, video or examples. The other spaces are primarily designed for prototyping and construction. Each space has large work benches with equipment such as 3D printers, laser cutters and other prototyping machinery around the perimeter of the rooms. The students (and staff as facilitators) move around from space to space as needed.

SEE326 – Artificial intelligence for Autonomous Systems

The unit revolves around a software project in which the students are given a game that they can play and they must write the A.I. code to play the game instead of them. The game,

whilst set in space, requires the same sort of A.I. that a warehouse robot would use. The students, using their only lap tops or similar, spend about 75% of their time in class working on and discussing the project.

The room's layout facilitates this process. By sitting in groups of up to 6 across a table, they are encouraged to discuss their problems with the project with each other. Previously, this unit was taken in a computer laboratory where everyone faced forward and the students would only discus items with one person next to them. Now, the greater discussion means a faster resolution of problems and more possible solutions.

The use of the wirelessly connected screen next to each table also helps this process as the students can display their code on the screen instead of having to gather around a small laptop.

The two large screens at the front of the room helps the lecturer. One screen can be used to run the game whilst the other can show a slide or the code that is being explained. This used to be performs by the lecturer displaying the code/slide, then switching to the game to show the application of the information given, then switching back again. The constant display flipping is stopped with the two screens as both the code and its application can be seen at the same time. This gives a better flow to the class and examples are related to more readily.

SEM313 – Manufacturing

The unit is based around weekly 2 hour studios where students focus on the application of unit-specific knowledge, analysis and tools (including digital literacy, software use, and test methodologies and data collection). The learning in the studios forms the basis for the final assessment task, which is a detailed manufacturing proposal for a bicycle frame (there are also 2 classes per week in a typical lecture theatre that focus on fundamental theory related the topics). During trimester the studios are split into several themes; material and process selection, cost, process and quality control, and material property control. Students work in groups during the studios using the collaborative learning spaces as a base, however, they are often required to use facilities in adjacent testing and characterisation laboratories or heavy equipment laboratories to complete the studio tasks. Students are often required to use software and internet-based literature or information sources during studios.

SEV353 – Reinforced Concrete Structures

The unit introduces the material properties and fundamental concepts for the design of concrete structures and its behaviour during service life. This includes introduction to the basic material properties and design parameters, flexural design of simply supported and continuous beams using Australian Design Code AS-3600, design of beams for shear and torsion, serviceability requirements, steel bond & development length, design of one-way slabs, design of two way slabs. Fundamental concepts for design procedures will be introduced through design classes and design projects.

The contact hours includes two hour lecture per week, one hour design class per week, and three X three hour lab sessions per trimester. However, the assessment tasks includes one design project (30%), one laboratory report (15%), and final examination (55%). Hence the unit is considered as partial DBL unit.

Results

A targeted survey was developed with 23 questions (Appendix A) with a mix of Leichardt scale or short answer response. The survey was split into three main themes; room layout and collaboration, audio-visual facilities, and use of the building. Students self-selected to participate and in total 33 respondents completed the survey. Of these respondents 32 were male, only 4 were international students, and there was a relatively even representation from each of the three disciplines.

The survey initially focused on whether students noticed a difference in the teaching style as a result of the new learning spaces, with over 70% in agreement. Comments from the question asking how the teaching style was different consistently mentioned the words 'group', 'discussion', 'interactive' and 'collaborative'. It should be noted that this question was asked in relation to the student's previous studies in the course, and not in relation to how these particular units were run in previous years using traditional lecture and tutorial rooms.

Room Lay-out and Collaboration

The overall response to the questions specifically regarding the room lay-out changes were positive with responses reiterating the more collaborative nature of the class highlighted in the previous section/question. 80 – 90% of the students agreed that the group seating enhanced student learning, that it enhanced student to student learning, that they preferred to be seated at a group table and that they interacted more with other students when seated at a group table. There were several disadvantages highlighted by students, with several noting that the learning spaces were poorly set-up when teaching staff used the room to lecture, as the TV screens were not large enough to easily see and that a substantial portion of the room had their back to the main screens.

Audio-Visual Facilities and Use

Students were generally in agreement that the AV equipment was a positive aspect of the learning spaces with 60-70% in agreement that they liked the equipment, that it enhanced their learning, that it made learning more interesting and that the teaching staff actually used it. Students responded that they thought the individual TV screens for each group were beneficial for group work, however, many comments stated quite strongly that the touchscreens were difficult to use and not as beneficial, compatible with certain tasks or user-friendly as they should be. Several thought having a wireless keyboard and mouse available would be better.

Building Use

Interestingly, the respondents were fairly divided on whether the learning spaces in the building affected their attendance, with slightly less than 50% agreeing that they came to class more because of the new learning spaces, and slightly more than 50% agreeing that they spent more time on campus because of the facilities available in the building. It should be noted that the 'disagrees' do not mean that they come to class less, just that they are not influenced by the new learning spaces or building.

Comments were quite varied when asked about their use of the building, with some liking the open study spaces, while others preferred the library as a better 'quiet' option. Several commented in relation to the requirement for BYOD. Bring Your Own Device (BYOD) has been a key and intentional focus of the new building design, however, this has not been well received by students at this stage. In fact it has almost universally disliked by students that responded to the survey. The particular cohorts covered by the survey have always had access to university supplied computer labs, however in the design of the new building, studio and collaborative spaces were given preference over computer labs. This preference to collaborative spaces and BYOD mimics industry trends (Thomson, 2012). Student comments are:

> "Computer lab, a lot of the engineering programs are free for us but running them on a laptop is not ideal due to the screen size and the processing time…"
>
> And
>
> "Computer labs with CAD programs such as SolidWorks and ANSYS installed on them to run these programs in a high quality…"

The incoming cohort of first year students in 2015 have had BYOD from day one and comments from the University-run student feedback survey has demonstrated that it has been well accepted amongst them. As an extension to the desire for computer labs from third and fourth year students in the current study, the need for more power points was also highlight by several students showing that what mobile computer resources that they do have needs to be supported by power for periods of time.

Conclusion

The results from this introductory study present some key thoughts and possible rethinking of the usability of spaces. The space that has been designed developed and now implemented shows that students whilst liking the space it does not necessarily encourage them to attend class more often. This initial study highlights that collaboration among students tends to increase so the space as intended has worked in that respect. It also shows that a change such as BYOD for an existing cohort tends to cause discontent whereas for a new cohort it is more easily accepted. Highlighted in the results are some more fundamental issues with devices such as adequate power points and accessibility of suitable technology to run specialist software. Highlights from the study are student comments reflecting and support the intent of the academics teams is that of increased collaboration and communication between students, teams and academics.

This study represents the bringing together of two major concepts of curriculum development and learning environments. Subsequent work this study will focus on aligning the curriculum and environment closer together to improve issues highlighted in the responses and garner a better understanding of two significant contributors to problem based learning.

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Acknowledgements

Dr. Riyadh Al-Ameri for allowing the authors to explore the SEV353 unit and asking student to completed the survey and Dr Siva Chandrasekaran and for the survey implementation; both assisted with the development of this piece of work.

Appendix A – Survey Questions

Question No.	Question	% Agree		% Disagree	
Q1	Which unit are you enrolled in?	SEE326 25%	SEM313 37.5%	SED402 28.1%	SEV353 9.4%
Q2	Your Gender	Male 97%		Female 3%	
Q3	What is your main mode of study?	On-Campus 87.5%		Off-Campus 12.5%	
Q4	Are you an international student?	Domestic 87.1%		International 12.9%	
Q5	The teaching style is different in the new learning space compared to traditional learning spaces	71.85		28.15	
Q6	How is the teaching style used in the new learning space different in this unit compared to other units using traditional teaching spaces (if at all)?	Short Answer			
Q7	The group seating in the new learning space enhances student learning	84		16	
Q8	The group seating in the new learning space enhances student to student learning	87.1		12.9	
Q9	I prefer to be seated at a group table than an individual table	83.3		16.7	
Q10	I interact more with other students when seated at a group table	90.6		9.4	

Q11	The learning space has more flexibility to meet my learning needs	76.7	23.3
Q12	What are the advantages and/or disadvantages of the new room layout?	Short Answer	
Q13	I like the new audio-visual equipment available in the new learning spaces	75	25
Q14	The new audio-visual equipment enhances my learning	62.5	37.5
Q15	The new audio-visual equipment makes learning more interesting	68.75	31.25
Q16	The new audio-visual equipment is used by the teaching staff in this unit:	71.9	28.1
Q17	What are the advantages and/or disadvantages of the available AV equipment?	Short Answer	
Q18	Do you see any opportunities for use of the AV equipment that were not used in this unit?	Short Answer	
Q19	I come to class more because of the new learning spaces in the CADET (KE) building	46.7	53.3
Q20	I stay on campus more because of the facilitates available in the new CADET (KE) building	58	42
Q21	How have you used the open (non-teaching) spaces in the CADET (KE) building for this unit?	Short Answer	
Q22	What other resources or accessibility would have been beneficial for this unit in the CADET (KE) building?	Short Answer	