AAEE 2012 CONFERENCE
Melbourne, Australia
www.aaee.com.au/conferences/2012/

From tiers to tables – enhancing student experience through collaborative learning spaces

Gary Rasmussen; Les Dawes; Doug Hargreaves; Jonathan James;.
Queensland University of Technology
Corresponding Author Email: g.rasmussen@qut.edu.au

BACKGROUND

Collaborative and active learning have been clearly identified as ways students can engage in learning with each other and the academic staff. Traditional tier based lecture theatres and the didactic style they engender are not popular with students today as evidenced by the low attendance rates for lectures. Many universities are installing spaces designed with tables for group interaction with evolutions on spaces such as the TEAL (Technology Enabled Active Learning) (Massachusetts Institute of Technology, n.d.) and SCALE-UP (Student-Centred Activities for Large-Enrolment Undergraduate Programs) (North Carolina State University, n.d.) models. Technology advances in large screen computers and applications have also aided the move to these collaborative spaces. How well have universities structured learning using these spaces and how have students engaged with the content, technology, space and each other? This paper investigates the application of collaborative learning in such spaces for a cohort of 800+ first year engineers in the context of learning about and developing professional skills representative of engineering practice.

PURPOSE

To determine whether moving from tiers to tables enhances the student experience. Does utilising technology rich, activity based, collaborative learning spaces lead to positive experiences and active engagement of first year undergraduate engineering students? In developing learning methodology and approach in new learning spaces, what needs to change from a more traditional lecture and tutorial configuration?

DESIGN/METHOD

A post delivery review and analysis of outcomes was undertaken to determine how well students and tutors engaged with learning in new collaborative learning spaces. Data was gathered via focus group and survey of tutors, students survey and attendance observations.
The authors considered the unit delivery approach along with observed and surveyed outcomes then conducted further review to produce the reported results.

RESULTS

Results indicate high participation in the collaborative sessions while the accompanying lectures were poorly attended. Students reported a high degree of satisfaction with the learning experience; however more investigation is required to determine the degree of improvement in retained learning outcomes. Survey feedback from tutors found that students engaged well in the activities during tutorials and there was an observed improvement in the quality of professional practice modelled by students during sessions. Student feedback confirmed the positive experiences in these collaborative learning spaces with 30% improvement in satisfaction ratings from previous years.

CONCLUSIONS

It is concluded that the right mix of space, technology and appropriate activities does engage students, improve participation and create a rich experience to facilitate potential for improved learning outcomes. The new Collaborative Teaching Spaces, together with integrated technology and tailored activities, has transformed the delivery of this unit and improved student satisfaction in tutorials significantly.

KEYWORDS

Collaboration, space, experience.

Introduction

Engineering education has always been delivered using a rich mix of learning forms and experiences. Laboratory exercises, field experiences, work integrated learning, tutorial sessions and lectures have made up the primary types of experiences and are implemented in varying ways and proportions of time. The lecture theatre with tiered seating and focus on strong lecture style didactic delivery may be viewed by many undergraduates as the "typical" class however, they do not feel they get a lot out of them according to Boles, Jolly, Hadgraft, Howard, & Beck (2010, p.152). Felder and Brent (2005, p. 57) explored differences in learning styles and the methods traditionally used in engineering courses. The lecture style as "one-size-fit-all", they observe, fits almost nobody. Low attendance rates at lectures also indicate the current student view of this mode of delivery.

Learning theory acknowledges active learning or learning by doing as very effective (Johri & Olds, 2011, p163) and active learning as it has been traditionally implemented in engineering courses through laboratory, field experiences and the like is truly engaging for students. Collaborative learning can engage students in learning with each other and the academic staff however it is initially more difficult to get students to participate (Boles et al p.141). As engineering educators and many other disciplines move to implement active and collaborative learning, new methods and new spaces are required. Lin &Tsai (2009) found that learning environments which are student centred, peer interactive and teacher facilitated help students develop more fruitful conceptions of learning engineering. A number of Australian engineering education researchers have published findings and practice related to these areas (Willey & Gardner, 2010; Trevelyan, 2010; Gardner and Willey, 2010; Buskes, Shen, Evans & Ooi, 2009). This paper explores whether moving from tiers to tables or tiered lecture theatres to the collaborative tables in active learning spaces enhances the student experience. Does utilising technology rich, activity based, collaborative learning spaces lead to positive experiences and active engagement? In developing learning methodology and approach in new learning spaces, what needs to change from a more traditional lecture and tutorial configuration?

The first year engineering unit selected as a large scale pilot for using this new approach at the Queensland University of Technology (QUT) was the unit Engineering & Sustainability (ENB100) which addresses professional practice and sustainability. ENB100 incorporates essential communication and research skills as well as covering sustainable engineering concepts and group work practices. The unit aims to inspire critical thinking capabilities in order to identify robust information sources and create solid, informed arguments. Historically this unit had been delivered in lecture and tutorial format with some components of project based collaborative methods in a variety of room configurations. In 2012 the unit was programmed for delivery in new Collaborative Learning Spaces being developed university wide. With more than 800 students enrolled, 24 tutorials with 17 tutors were required. To achieve a uniform learning experience run sheets and slides were provided to all tutors. Each tutorial was timetabled in a Collaborative Learning Space (CLS), with at least 6 Mobile Collaborative Workstations (MoCoWs) capable of working individually or connected in unison. All classes were timetabled in these spaces for 2 hours per week and 1 hour lecture in a tier format theatre.

This paper investigates the application of collaborative learning in such spaces for a cohort of 800+ first year engineers in the context of learning about and developing professional skills representative of engineering practice.

Learning space design

Many universities are developing new active learning spaces and some are providing research on their practice and use such as the University of Minnesota as reported by Aimee, Whiteside, Brooks, & Walker (2010). Spaces are designed with tables for group interaction and computing technology with some examples being the TEAL (Technology Enabled Active Learning) and SCALE-UP (Student-Centred Activities for Large-Enrolment Undergraduate Programs) models. Technology advances in large screen computers and applications have also added to the mix of learning and delivery opportunities in these spaces.

New spaces designed to facilitate active and collaborative learning supported by technology are know by many names. They are all moving toward the mix of furniture, layout and technology that support active and collaborative learning. In this paper the authors will refer to the space generically as Collaborative Learning Space (CLS).

The design of what is sometimes also referred to as 21st Century or Next Generation Learning Spaces is very well documented now with organisations such as the Joint Information Systems Committee in the United Kingdom producing comprehensive design guidelines. "A learning space should be able to motivate learners and promote learning as an activity, support collaborative as well as formal practice, provide a personalised and inclusive environment, and be flexible in the face of changing needs" (Joint Information Systems Committee, 2006, p3).

In another significant work, Learning Spaces, Oblinger (2006, p1.1) in the editors introduction comments; "Many of today's learners favour active, participatory, experiential learning" and that "their behaviour may not match their self-expressed learning preferences when sitting in a large lecture hall with chairs bolted to the floor". The book seeks to reconceptualise learning spaces to facilitate active, social, and experiential learning."

"Spaces are themselves agents for change. Changed spaces will change practice" (Joint Information Systems Committee, 2006, p30). This reference implies a change based on space however the change and the space design itself is also driven by practice.

A plan and typical fit out for CLS used in this unit at QUT are shown in Figure 1.

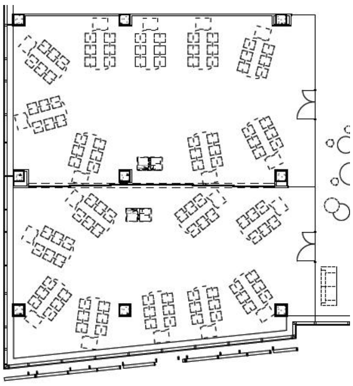

Figure 1: Collaborative Learning Space plan and fit out

Changed practice in changed spaces

Creating immersive experiences that draw on infrastructure, technology and activities necessitates a unique approach to unit design. For large class sizes, it also requires a team approach of engaging staff to facilitate the experiences. For this first year engineering unit in professional practice and sustainability a group of staff engaged to create activities with run sheets to enable facilitation of the sessions by tutors with a diverse range of experience. This staff group, the authors, have substantial experience in tutoring and in delivery of experiential learning in the laboratory environment over many years. Two of the staff are senior academics and two are professional staff at QUT. This team approach was useful in bringing together wide experience to apply to the design of activities for new spaces.

The Australian Learning and Teaching Council supported project, Designing Next Generation Places of Learning, developed the Place for Learning – Spectrum shown in Figure 2. The project outcomes support institutions in developing and using learning spaces that will encourage student engagement and improve learning outcomes (Radcliffe, Wilson, Powell, & Tibbetts, 2008). Indicated in the spectrum by the CLS box added, is the range of activity types that are commonly being employed in the unit ENB100 considered here.

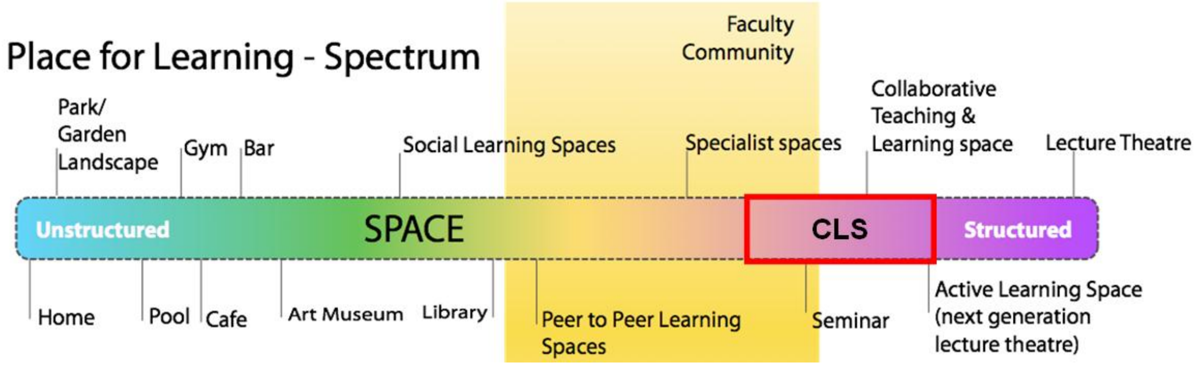

Figure 2: Place for Learning – Spectrum
Adapted from (Radcliffe et al., 2008)

Tutors mainly act as facilitators of the learning process as students engage in planned activities. However from time to time they will explain, provide scaffolding or give guidance in a more directional way. Students work in their set groups collaboratively on the activity or the project and at times report back to the class in general feedback or more formal student presentation style. The new spaces allow for the full range of activity and the computing technology supports the activities and aids in keeping the groups focused on the tasks.

Changes in learning space design and delivery are well under way at QUT. Course delivery is changing, new laboratories with flexible and connected areas are engaging students, and a new Science and Engineering building with a mix of supportive and enabling spaces across almost the full spectrum indentified in Figure 2 are changing the learning landscape for our students. QUT has used pilot spaces to inform learning space design and practice in collaboration with a community of learning practice and the architects. While this is not the focus of the paper it is the context in which the practice addressed here is framed. In 1997, Hargreaves and Ternel (1997) argued that “in order to meet the needs of students the role of the engineering educator needs to change from ‘teacher’ to ‘facilitator.” Much more work is required including significant change of practice, staff development, space change and research and analysis, to challenge and change some long held norms.

Theories on teaching and learning for adult learners are constantly being reviewed and discussed in the higher education environment. McAuliffe, Hargreaves, Winter and Chadwick (2008) discuss three of these theories, pedagogy, andragogy and heutagogy. Of these three theories, the andragogy model developed by Knowles (1984) probably best aligns with the approach taken in the current project. This model provides the learner with the reason why something is important to learn, shows the learner how to direct themselves through information, relates the topic to the learner’s experiences (individuals will not learn until ready and motivated to learn) and finally utilises a life-centred, task-centred or problem-centred approach to learning. The model emphasises the need for the learner to take responsibility for their learning and moves from dependency to independency or self-directedness.

Methodology

Using CLS for all tutorials in the unit enabled delivery to be active, use enabling technology, the MoCoWs, and support group collaborative methods. Key areas of focus were group formation, group dynamics, activity alignment with content, and collaborative learning with peer support in the groups. The unit had been conducted using the lecture/tutorial format in the past and had a group project central to the delivery. It had however been delivered in a variety of tutorial spaces including flat tutorial rooms and some tiered rooms that were totally unsuitable for the style of delivery. The method for this new approach was to continue to deliver a one hour lecture and to hold all tutorials in CLS with a redeveloped delivery style and approach. The diverse experience of the teaching team, the authors, contributed to the creation of multiple class activities designed to engage students and allow for group work on the content. Professional practice was explored, practiced and expected in the sessions. The Engineers Without Borders (EWB) challenge continued to be the central project for groups and formed a major part of assessment. Students were also required to complete progress reports individually that were handed in during tutorials where feedback was also provided on the reports. PowerPoint presentations and run sheets were developed for tutors to facilitate the sessions, standardise the message and assist tutors in focusing on delivery and not solely on content.

Student groups formed quickly and naturally in the CLS. The tables with six places and one MoCoW meant that students were in preliminary groups from the start as they took their places. Group members engaged with each other and the technology immediately, enabling tutors to assist in refining the group membership. The group focus of this unit replicates short term work teams common in engineering practice. Students were able to experience group dynamics and guided to appreciate the benefits and be aware of and resolve difficulties. Group based activities and the EWB challenge project were central to the approach. Constant facilitated activity and positive engagement strengthened the groups into teams rather than a loose coalition of learners.

The first activity with preliminary teams was conducted within the first hour of the first tutorial. For the majority of students, it was their first simple engineering challenge in designing and construction. The task was to build the tallest and most iconic tower from 50 business cards and 100 paper clips. In the 30mins allocated, tutors were able to assess the mix of each team and identify changes to makeup. The teams were advised that during the construction phase they may be asked to swap. Teams were formed during this activity with the aim of establishing the final makeup before the end of the first tutorial.

The ability for teams to access resources immediately through their MoCoW enabled content to be live, responsive and largely driven by the student teams. For the tutors, the new delivery techniques changed their roles from content expert to guide and facilitator. Keeping teams on task now meant encouraging them to find a wide variety of information, analyse it for appropriateness and quality and synthesise it with the activity content. No paper based resources were provided with some resources provided for investigation and inclusion and much discovered by the teams utilising the rich and extensive online material.

A team approach was used in developing and delivery of the unit made up of the authors who also all conducted tutorials. All tutors were asked to participate in a post delivery review and survey. Data were gathered in the focus group review and paper based survey for tutors relating specifically to their experience with the learning activities and CLS used in tutoring ENB100. Student surveys (on-line and hard copy) followed the university standard learning experience survey which focused on individual satisfaction of the unit. The authors considering the unit delivery approach along with observed and surveyed outcomes and conducted further review to produce the reported results.

Results and Discussion

Data collection involved distributing survey questionnaires to all tutoring staff and online and hard copy surveys of students. A five part Likert scale (strongly agree – strongly disagree) was used for questions. Response rate for the tutoring staff was 59% (n=10). Teaching staff ranged in experience and included 3rd and 4th year engineering undergraduates, engineering postgraduates, professional staff and early career to senior academics. Table 1 shows demographic data for tutoring staff for the survey responses.

Tutors

Table 1: Tutor Details

Demographics		Number: n = 10
Gender	Male	7
	Female	3
Age	<20	1
	20 to 25	1
	26 to 40	3
	>40	4
Experience teaching	Years	1 to 20
Tutored Unit before	Number	4
Used Collaborative Spaces before	Semesters taught	0 to 4

Survey questions related specifically to tutors experience and class observations with the various learning activities in the CLS. Table 2 shows responses to the question "In your experience in ENB100 tutorials in 2012, how would you rate the extent to which students engaged in the learning activities by..."

Table 2: Tutor Survey Results

Extent students engaged in the learning activities by;	Strongly Agree	Agree	Not sure	Disagree	Strongly Disagree
Group collaboration	8	2			
Use of technology	6	4			
Level of enthusiasm	3	4	3		
EWB Project*	3	6	1		
Progress Reports		5	4	1	

Numbers = tutors who answered * = Engineers Without Borders challenge 2012

All tutors agreed, regardless of experience and status, that group collaboration and use of technology enhanced engagement in the learning activities in these collaborative spaces. Nine of the ten tutors identified that the activities and CLS contributed successfully to the learning outcomes of the unit and the overall enjoyment for them and their students. One tutor commented:
"*The space allowed quick transition into group activities as well as allowing groups to form naturally*."

Another commented that "*students were engaged in activities through participation and interactivity of class.*"

Many tutors noted that using the CLS changed their expected classroom experience by deepening the relationship they had with their students and felt their role shifted to that of a facilitator rather than a teacher. The training of tutors in the use of CLS is a one off cost and will reap benefits across a range of teaching contexts wherever those tutors are deployed. During teaching team meetings, the sharing of ideas, thoughts and experiences assisted in the development of approaches to facilitating collaborative learning activities.
Zemke and Zemke, (2008) in a study on structured team based learning design tasks captured by video analysis found student engagement ratings and the collaboration space ratings roughly track each other. The higher the engagement, the more likely the discussion involved a rich source of ideas being assessed and built. In contrast, the lower the engagement, fewer ideas were considered and the simpler the thinking about them. This corresponds with ENB100 tutors observations in CLS.

Tutors identified the following worked best in terms of student interest and engagement:

- Interaction in groups and then with class when communicating activity outcomes
- Group discussions and ability to search and share media
- Practicing presentation skills
- Showing clear links to engineering application and profession

The activities that generated least student interest and engagement were identified as:

- Developing group rules
- Learning about the library
- Writing exercises and referencing
- Progress reports

Students

Student response rates varied with an online survey 17.8% (n= 138) and hard copy 33% (n=251). Student feedback through both electronic and hard copy surveys found that CLS were very effective for group work and collaborative projects. Comments from all survey questions were collated to determine level of engagement with the designed activities and learning spaces. 65% of students (58% liked; 7 % disliked) responded with written comments on the tutorial activities. This represents an extremely high response rate indicating they were engaged and made an effort to respond.

Student responses on the QUT on-line survey of this unit were very encouraging. The average response to the question 'Overall satisfaction for teaching' was 4.5 (out of a possible 5.0). This is a significant improvement over past years. The Faculty average was 4.1 and given that this unit has 850 students enrolled, this is regarded as an outstanding result. Student satisfaction with tutorial sessions was 90.6%; about 30% higher than the Faculty average. This result is a clear indication that the combined use of CLS and directed activities (student engagement) provided a learning experience valued by students. Attrition rates also reduced appreciably from previous years with the 2012 figure of 9.6%.

Tutors provided both formative and summative feedback throughout the semester. Formative feedback occurred every week when students were required to make short and sometimes ad lib presentations to the whole tutorial class. Students were assessed each week by the submission of a progress report. The task varied each week with students required to submit a short answer to a specific task. The intention was to develop professional written communication skills and awareness of engineering practice. Student response to this was two-fold; they rated the feedback very highly but thought the workload was a bit too high.

Results of attendance indicated high participation in collaborative sessions whilst accompanying lectures were poorly attended after the first few weeks. Figure 3 clearly demonstrates lecture attendance decreasing markedly over semester whilst tutorial attendance in CLS remained high throughout semester.

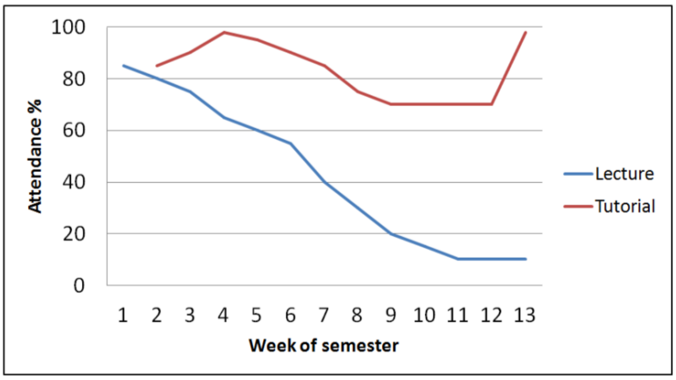

Figure 3: Attendance Records ENB100 2012

The CLS yielded very positives responses from students, see Table 4. Positive comments relating to the tutorials far outweighed the need of improvement comments which mainly focused on progress reports. Progress reports were weekly reflections related to lecture material and restricted to a maximum of 2 pages. Many students commented on the workload required to complete, while others described them as valuable to their learning. Survey data was also supplemented with informal observations of students by tutors in class. Student satisfaction ratings of tutors were high (lowest score 4.3 out of 5) across all the classes even though there was a very significant demographic range of tutor age and experience. This may be attributed to the uniformity of structured group activities across the whole class and the students seeing the relevance and connecting activities to learning outcomes and engineering practice.

Table 3: Selected Student Survey Comments

Tutorials were very relevant and helpful
Tutorials were engaging and interactive
Group work improved team skills
Tutorials provided an understanding of what a career in engineering involves
Weekly progress reports are a good way to assist and boost the learning process
Helped develop communication skills
Tutorials are always energetic and everyone contributed
Gaining a great understanding of expectations of the profession and importance of communication
Benefited from feedback after presentations
Tutors were good role models
Critical thinking skills helped in achieving a good project outcome
Learning to work with others, especially people with different backgrounds
Loved the interactive learning space

Conclusions

Moving from tiers to tables in this unit has enhanced the student experiences with collaborative learning and active engagement. In developing learning methodology and approach in new learning spaces much more work is required including significant change of practice, staff development, space change and research and analysis, to challenge and change some long held norms.

The right mix of space, technology and appropriate activities does engage students, improve participation and create positive experiences for improved learning outcomes. The new Collaborative Learning Spaces, together with integrated technology and tailored activities has transformed the delivery of this unit and improved student satisfaction in tutorials significantly.

References

Aimee, L., Whiteside, D., Brooks, C., & Walker, J. D. (2010). Making the case for space: Three years of empirical research on learning environments. Retrieved Aug. 12, 2012, from www.educause.edu

Boles, W., Jolly, L., Hadgraft, R., Howard. P., & Beck, H. (2010). Influences on student learning in engineering: Some results from case study fieldwork. *Australasian Journal of Engineering Education*, *16*(2), 149-165.

Buskes, G., Shen, B., Evans, J. & Ooi, A. (2009). Using active teaching workshops to enhance the lecture experience. *Proceedings of the Australasian Association for Engineering Education Annual Conference,* Adelaide, SA.

Felder, R. & Brent, R. (2005), Understanding student differences, *Journal of Engineering Education*, 94(1), 57-72

Gardner, A. & Willey, K. (2010). Critical conversations: How collaborative learning activities prepare students for structural engineering practice. *Proceedings of the Australasian Association for Engineering Education Annual Conference,* Sydney, NSW.

Hargreaves, D., Ternel, I. (1997). The changing Role of the Engineering Educator. *Proceedings of the Australasian Association for Engineering Education Annual Conference,* Ballarat, NSW.

Johri, A., & Olds, B. (2011). Situated Engineering Learning: Bridging Engineering Education Research and the Learning Sciences. *Journal of Engineering Education*, 100(1), 151-185.

Joint Information Systems Committee. (2006). Designing Space for Effective Learning: A Guide to 21st Century Learning Space Design. Retrieved August 12, 2012, from www.jisc.ac.uk

Knowles, M.S. (1984). *Andragogy in Action*, 1st edition, San Francisco, Jossey-Bass.

Lin, C.C. & Tsai, C.C., (2009). The relationship between students' conceptions of learning engineering and their preferences for classroom and laboratory learning environments. *Journal of Engineering Education,* 98(2),193-204

Massachusetts Institute of Technology. (n.d.). Technology Enabled Active Learning. Retrieved August 12, 2012, from http://web.mit.edu/edtech/casestudies/teal.html

McAuliffe, M, Hargreaves, D, Winter, A. & Chadwick, G. (2008). Does pedagogy still rule?, *Proceedings of the Australasian Association for Engineering Education Annual Conference*, Yeppoon, Qld.

North Carolina State University. (n.d.). Student-Centered Active Learning Environment for Undergraduate Programs. Retrieved August 12, 2012, from www.ncsu.edu/per/scaleup.html

Oblinger, D. G., ed., (2006). *Learning Spaces*. Retrieved from www.educause.edu/learningspaces

Radcliffe, D., Wilson, H., Powell, D. & Tibbetts, B. (2008) Designing Next Generation Places of Learning: Collaboration at the Pedagogy-Space-Technology Nexus. Retrieved August 12, 2012, from www.uq.edu.au/nextgenerationlearningspace/

Trevelyan, J. (2010). Mind the gap: Engineering education and practice. *Proceedings of the Australasian Association for Engineering Education Annual Conference,* Sydney, NSW.

Willey, K. & Gardner, A. (2010). Collaborative peer learning to change learning culture and develop the skills for lifelong professional practice. *Proceedings of the Australasian Association for Engineering Education Annual Conference,* Sydney, NSW.

Zemke, S & Zemke, D., (2008) Structuring Team Learning Tasks to Increase Student Engagement and Collaboration, *Proceedings of the American Society for Engineering Education, Annual Conference*, ASEE, Pittsburgh.

Copyright statement