Australasian Partnership in a First Year Engineering Course: Deakin University and Wuhan University of Science and Technology

Dr. Sivachandran Chandrasekaran P.E., Deakin University

Dr. Sivachandran Chandrasekaran is a Research Fellow in Engineering Education at Deakin University. He has graduated his BE (CSE) in India and ME, MES (Electronics) from Victoria University and PhD (Engineering Education) from Deakin University respectively. He is active member of Deakin engineering education research Centre (DEER), School of engineering in the Faculty of science, Engineering and Built Environment at Deakin University. Siva is an active researcher and his research interests include creativity and innovation in learning and teaching, Design based learning, Cloud learning & located learning and engineering education innovation. His education philosophy is founded on the Project Oriented Design Based Learning (PODBL) approach at Deakin University.

Dr. John Matthew Long, Deakin University

Dr. John M. Long completed his undergraduate degree in physics at the University of Michigan (Flint) in 1987, while working as an analytical chemist at AC Spark Plug, General Motors Corporation. In 1995 he completed a PhD in physics at Monash University in Melbourne, Australia. Since then he has worked in the School of Engineering at Deakin University, where he teaches physics, materials, and electronics. His research interests include materials-analysis techniques and engineering education.

Dr. Yanan Wang P.E., School of Engineering, Deakin University, Warrnambool, Victoria, Australia
Dr. Junior Nomani JN, Deakin University

Prof. Qiang Zhao
Prof. Roger Dianlei Geng PhD, Wuhan University of Science and Technology

Education: 2008-2015 PhD: Shanghai International Studies University Work: 2010-Present Professor of English and Cultural Studies Director, Office of International Relations/Dean, International School Wuhan University of Science and Technology, China

Prof. Bernard Rolfe, Deakin University

Bernard Rolfe completed a combined Economics and Engineering degree with honours in 1995 from the Australian National University (ANU). During his degree he was employed as a graduate research engineer at the BHP Research Labs, investigating better control systems for hot strip steel mills. After he obtained his degree he worked for several years as a Business Systems consultant with Andersen Consulting (Accenture) before returning to the ANU to pursue a PhD in novel methods of inverse modeling metal forming processes (completed in 2002). This research included an IMechE award winning journal paper. In 2005 Bernard joined Deakin as a Lecturer in Mechanical Engineering. In 2008 Bernard led the Deakin’s successful team for “Creating the Model-T for the 21st Century – a Global University Challenge”. This vehicle concept outclassed several other top Universities around the world to be awarded joint winner along with the concept from the University of Aachen (RWTH), along with $25000 prize money. In 2015 Bernard received the Vice Chancellor’s award for Industry Engagement. Currently Bernard is an Associate Professor (Mechanical) at Deakin University in Australia. This is equivalent to a tenured Professor in the US system. He has been a part of over fifteen successful nationally competitive large research grants, totalling over $15 million in awarded funds. He has published over 150 refereed articles. His current research focus is the forming of light weight structures, including the development of better material models for metal forming.
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Abstract
This paper presents the results of domestic Chinese undergraduate engineering course taught by international Australasian teaching staff. The project is a part of a teaching collaboration between Deakin University and Wuhan University of Science and Technology. The cohort of students from Wuhan was a freshman undergraduate engineering course in mechanical engineering. The particular subject was a freshman engineering-materials course taught in English. The course covered an introduction to material-science principles and practices. A survey was used for evaluating student perceptions. It is aimed that this study will help academics from Deakin University to better understand student experiences, and to identify the current challenges and barriers faced in student learning. Analysis of the survey has shown that 90% of students agreed that they were motivated to learn and achieve the learning goals through this collaborative program. Around 90% of students found that group-based practical activities were helpful in achieving learning goals. Overall, 90% of students strongly agreed they were satisfied with the method of teaching.

Introduction
Engineering is increasingly seen as a global, international field. As such, one sees an increasing number of international collaborations in teaching undergraduate engineering. There are many examples of international teaching initiatives found within the ASEE conference proceedings. (See for example, papers by Jaselskis, Liu, Parsaei, Fayez, and their colleagues.) This paper describes a novel teaching partnership between two university engineering departments in Australia and China.

Wuhan University of Science and Technology (WUST) is a public university providing formal higher education courses and programs in Wuhan, Hubei Province, the People’s Republic of China (figure 1). In 2012, Deakin University (Deakin) and WUST agreed to establish a cooperative teaching program in China, the Bachelor of Engineering degree in Mechanical Engineering and Automation, which was subsequently approved by Ministry of Education, China in 2013. The first intake of students from Hubei province was recruited in the same year. The purpose of the cooperation between the two universities is to establish a collaborative relationship for complementing the similar program existing at WUST; and to provide students with education of an international standard through exchange of internationally advanced teaching methods and resources. It is the hope of both universities that this relationship will provide opportunities for educational and cultural exchange between students and staff of the two universities and contribute positively to the relationship and goodwill between Australia and China.

In this program, Deakin sends its teaching staff to WUST each semester to deliver intensive teaching over a two-week period (40 hours) for 13 core courses from sophomore year to the senior year. There are also WUST academic staff who co-deliver each of these courses for 32 hours, which results in 72 teaching hours in total for each course. All the teaching, learning and assessment materials are provided.
by Deakin. Some minor adjustments are made before they are used to teach and assess students at WUST. The focus of this paper is to discuss the learning-and-teaching approach involved in this collaborative program. It also will discuss some of the challenges faced by the students in the program.

Figure 1: Locations of Wuhan University of Science and Technology (left), and Deakin University in Victoria, Australia (right).

In a multi-disciplinary curriculum setting, learner-centred curricula and pedagogical practices are at the heart of international collaborative-learning programs. The vision of this project is to provide students with a collaborative-learning experience specializing in the theories and applications of advanced technology in mechanical engineering. The graduates in this collaborative program will be equipped with the fundamental knowledge, expertise and learning capacity such that a science-literate and innovative mind can prepare them for work in product and process modelling and also in design as a researcher, manufacturer, developer or administrator.

Teaching and learning with a design-centric curriculum
Each participating institution has at least one representative for each course, a teaching academic, an assessor, and an overall program director. A steering committee consisting of engineering academics and academic deans guides the project in WUST. An internal research review team evaluates the project annually as part of an ongoing longitudinal study. The curriculum approach is based on design-based learning (DBL), a combination of problem-based learning and project-based learning. With different learning styles, students (figure 2) are able to express their skills and talents through working on projects or by simply designing experiments in authentic learning environments. Integrating design and technology tools into science education provides students with dynamic learning opportunities to actively investigate and construct innovative design solutions. A design-based learning environment assists the curriculum to move into the twenty-first century with students being hands-on in their work, in addition to using problem solving skills, engaging in collaborative teamwork, creating innovative designs, learning actively, and engaging with real-world problems.

The collaborative teaching in undergraduate engineering education has a number of features:
- A design-based learning curriculum approach in teaching and learning,
- Student projects around problem/design activities,
• Team-based learning/collaborating learning in classroom seminars,
• Teaching and learning assessment/evaluation processes.

The main goal of teaching and learning through a design-focused curriculum is to increase student learning through problem solving, active/collaborative learning, student-directed learning and analytical thinking. This DBL approach is different from traditional teaching. The School of Engineering at Deakin University has always tried to improve its course delivery method to enrich the student experience and to produce capable job-ready engineering graduates. To this end, it has explored new teaching methods to aid in this process. One such method is design-based learning (DBL). Unlike problem-based learning (PBL) and project-based learning (PJBL), DBL is a self-directed learning approach and opens up learning activity so design skills must be learnt and applied. Students must locate the resources required, and analyse any needs in order to create a design. This method gives students the freedom to apply their design skills as they think best. DBL not only looks at the end product but also at the underlying process in creating that product.

Course outline
The course was a sophomore engineering-materials unit. It focused on the introduction of basic concepts of material selection and the fundamental properties of the main material classes: metals, polymers, ceramics. The course also taught different types of material failure and how to select materials to avoid failure. The types of failure topics addressed include yielding, creep, wear, fatigue and fracture. The course text material was based around two popular materials textbooks. Traditional teaching in China tends to be rote learning, more passive than active. This course employed an inquiry-based approach with a combination of integrated class/seminars and laboratory-demonstration classes. The Deakin-led classes consisted in two hours of lecture, followed by a two-hour practical class. The practical classes focussed on six aspects of materials science and engineering:
• Stress and strain in materials
• Material properties
• Strength limits in engineering components
• Crack propagation in failure
• Failure by fatigue
• Materials selection.

Students used these experiences as the starting point for design and research-based activities. In the process of teaching, flexible use of various teaching methods, such as presentation, discussion, competition and so on, were employed to arouse student interest in learning materials and improve learning. For example, figure 3 shows students performing a materials-selection exercise, following the procedures developed by Ashby. What’s more, this materials course had a higher requirement on practical work than in more traditional Chinese courses. In addition, several experts were invited to give guest lectures on materials. The assessment of this course was 50% final examination, 10% attendance, and 40% mid-semester examination. The minimum passing grade was 60%. Sixty-three students completed the course with their learning assessed.

Figure 3: WUST students working on a materials-selection exercise - materials for a ship propeller.

**Methodology to determine student perceptions**

When considering the significance of student learning outcomes and the teaching requirements of staff in engineering education, this research intends to encapsulate the perspectives of students about a new learning-and-teaching approach. The School of Engineering at Deakin has used DBL as one of its engineering learning principles for further development in teaching and learning. It is required to improve the learning-and-teaching process as a holistic approach from the perspective of students and staff over the entire collaborative teaching program at WUST. A qualitative and quantitative paper-based survey method was used to obtain student perspectives on the course. Qualitative methods are useful for evaluating developing program goals and for involving participants in the evaluation process to gain their insight and perspective.
The survey questions were designed to determine the students’ level of experience from their first year of undergraduate engineering. The views of students on collaborative learning using project/design-based learning approach in this research come from all levels of undergraduate engineering. From the quantitative and qualitative analysis performed, the results are analysed and presented from a students’ perspective about project/design based learning practice in a particular unit. The survey was given to more than 100 students across multiple courses in the first year of engineering. It was anonymous and non-identifiable. These results are from students’ own experiences and the results present various views, which include students’ knowledge and expectations. In turn this can inform the collaborative program to enhance the international student-learning experience. In line with ethics process and procedures, a third party conducted the research survey. The questions were prepared to identify the challenges in teaching and learning and in particular to investigate student perspectives on the practice of collaborative teaching. The survey questions used in this research were:

1. Are you motivated to learn and achieve the learning goals in this unit?
2. Are you comfortable to participate and interact in the practical?
3. Does the group based practical activities are most helpful to achieve learning goals?
4. Does the practical activity tasks helped you to obtain skills such as communication skill, teamwork skill, design skill, problem-solving skill?
5. Do you understand the subject and the teaching approach?
6. Overall, are you satisfied with this way of teaching?

Overall assessment grades
Figure 4 summarizes overall assessment grades of students. It shows that over 50% of students achieved greater than 60% of the maximum final-assessment score. A direct comparison between this course and WUST’s traditional materials course is not possible because this course and its corresponding traditional course taught in Mandarin had slightly different content and different textbooks. However, from the perspective of similar courses at WUST, this shows an above-average pass rate. Only two students achieved lower than 59% of the maximum possible score and thus failed the course. In a traditional WUST course in materials science, the pass rate is approximately 85%.

![Figure 4: Final overall assessment marks of the students.](image)
Survey results

Of equal importance to academic performance is the student experience. A total of 61 students participated in the survey. In the materials course considered here, the students’ perceptions on their learning experience are shown in figures 5-7. For questions 1 to 7, the most common response was agreement. The most questions with which students agreed were questions 1 and 3. A total number of 91% of students agreed that the collaborative teaching had motivated them to achieve the learning goals. 82% of students agreed that the group-based practical activities were most helpful towards achieving the learning goals.

Around 37% of students disagreed that the subject and the teaching approach was not understandable. The student responses to question 5 indicated that the students have a communication issue in the learning environment. It is obvious that communication plays a significant role towards teaching and understanding the subject when it is being taught in a second language. This area should be investigated further to better understand the underlying reasons for the high number of disagree responses.

Figure 5: Student feedback responses
The student responses to questions 2, 6 and 7 in the survey were similar. The combined number of agreed responses for these questions ranged between 70-77%. We can say that of the students surveyed, they felt similar about being satisfied with the teaching method and also that the practical activity task had increased their learning compared to traditional learning. Also, the students generally felt comfortable in participating and interacting in the practical activities. That being said, there remains 25-30% of students who were not comfortable with the new learning environment. Future offerings of this course will address this to increase student satisfaction.

When students were asked about what skills they obtained from the practical activities, again most of the responses clustered towards the agree response, shown in figure 5. The most interesting response was the feedback towards design skill, which saw an equal number of responses for agree and disagree at 45% each. However the responses appear be slightly skewed towards agreement, indicated by the greater number of strongly-agree to strongly-disagree responses. Problem-solving was indicated as the higher trend towards agreement, in terms of skills developed from practical activities, followed by teamwork skill and communication.

Q4. THE PRACTICAL ACTIVITY TASK HELPED ME TO OBTAIN

![Bar chart showing student feedback response for Question 4.]

There is some continuity when comparing the number of agreed responses querying communication skill in question 4 (figure 6), and the number responses to the open-ended question, mentioning communication skill as being what they found most useful in this unit. Figure 7 shows that 56% of open responses mention communication as being most useful. This was followed by 14% of the comments related to teaching being most useful, then practical activity tasks at 9%, concluded by teamwork 7%. Other individual non-related comments made up 14% of the open-question responses.
Discussion

The overall assessment shows that most of the students in the class experienced a quality learning experience through collaborative teaching. As indicated in figure 4, around 50% of students achieved higher grades by adopting to a new collaborative teaching. According to the survey results discussed above, over 90% of students mentioned that the new collaborative teaching motivates to learn and around 77% of students felt that the practical activity enhanced their learning compared to traditional learning. Based on analysing the final exam grades, we found that students had a good understanding of theoretical-knowledge-based content. However the students found difficulties in applying this theoretical knowledge to practical problems. For example, on the exam there was a question on how to select a material for a bicycle frame. Ninety percent of the students did not give a correct answer. In order to improve student understanding of the application of theory to real-world problems, in the future more practical case studies will be introduced.

From the survey results, about 82% of students agreed that the group-based practical activities were most helpful towards achieving the learning goals. The project/design-based learning activities have enhanced students learning capability of understanding practical/theoretical prospects in this course. Most of the students mentioned that communication plays an important role towards teaching and understanding of the subject when it is being taught in a second language by the academics from Deakin. On the other hand, students found that understanding the Deakin lecturers’ unique Australian accent to be quite a challenge. (Incidentally, one of the authors experienced the same thing with another group of Chinese students who were studying a similar materials course in Australia. One lecturer was Australian, the other American. These students found the American lecturer easier to understand than the Australian one.) Our future work will include even greater cooperation between Chinese and Australian instructors to ensure the best possible learning experience. The course certainly gave the students an opportunity to learn and experience internationalism in an academic environment.

Anecdotally, across the entire Deakin-WUST program, we noticed that at the start, students tended to be quiet and passive. There was little interaction and engagement between the lecturers and students.
(We admit that teaching the classes in English was a contributing factor.) Three semesters later, we noticed that the students became more engaged with the lecturers, more responsive, and more likely to initiate discussion. As this is one of the goals of the program, we see this as a positive result and look forward to backing up this observation with better data.

As far as design-based learning is concerned, in the next few years of the partnership, the teaching team plans to

- Organise DBL workshops for faculty and students,
- Continue the DBL teaching approach through design problems around projects,
- Analyse and improve students learning experiences and difficulties,
- Publish staff and student perceptions for future case studies.

**Conclusion**

Deakin University in Australia and Wuhan University of Science and Technology in the People’s Republic of China have begun a teaching partnership in undergraduate engineering, whereby Deakin courses are taught to WUST students in English. Deakin academics visit Wuhan during the semester to provide intensive classes over a few days. The teaching method centers on design and project-based learning. A trial of this partnership in a sophomore course in materials engineering resulted in good academic results from the WUST students. Surveys of student satisfaction indicated that the students were for the most part satisfied with the course and the novel teaching methods. However, as the course was taught in English and not in the native Chinese, students found communication to be a considerable challenge. Greater cooperation between Australian and Chinese teaching staff will be used to overcome this language barrier.

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**References**


