

# Intensive Mode Teaching for the delivery of engineering content to students at a Chinese university.

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**SESSION** Integration of theory and practice in the learning and teaching process'

**CONTEXT** Interactive Intensive Mode Teaching (IMT) techniques were used to deliver an engineering design and project management unit at a Chinese university. A proportion of Chinese students studying this unit transferred to the University of Tasmania to complete a Bachelor of Engineering with Honours degree in a further two years (2+2 Program). The unit was delivered over a period of six weeks to large classes (75 and 115 students). At the same time students intending to transfer to UTAS undertook an English language academic skills unit. Both units were facilitated by the introduction of an on-line learning management system (Cloudcampus).

**PURPOSE** This study examines the effectiveness of the interactive IMT technique for the delivery of KNJ211 *Engineering Design and Project Management* by comparison with the traditional, didactic style of teaching employed by the same teacher in the previous year; the synergy between the engineering unit and an English language unit, delivered by the second author at the same time, is also explored.

**APPROACH** The effectiveness of interactive IMT delivery was evaluated through students' performances in aligned assessment tasks comprising a 5-minute video report on design studio group-work, in-class tests of content knowledge and an individual task. Students' engagement with IMT is examined through the lens of their use of Cloudcampus.

**RESULTS** The students' overall and in-class test results were significantly different from those of the previous year when the unit was delivered by the teacher-centred didactic method. A factor that may have contributed to this outcome is students' unfamiliarity with accessing the on-line content.

**CONCLUSIONS** Students' technical English language skills present a challenge to effective delivery of engineering content. Some IMT techniques proved to be effective.

## KEYWORDS

Intensive Mode Teaching  
China  
Engineering

## Introduction

Academics from the University of Tasmania (UTAS) deliver first, second, third and fourth year engineering subjects to students at Chinese universities. Some of these students choose to graduate with a Bachelor of Engineering with Honours degree by completing their final two years at UTAS (2+2 Program). The interactive Intensive Mode Teaching (IMT) technique recommended by Male et al. (2016), developed specifically for the delivery of engineering among other content, was used to deliver a second year engineering unit KNJ211 *Engineering Design and Project Management* to large classes (approximately 100 students) at a Chinese university over a period of six weeks in May-June 2017. At the same time students intending to transfer to UTAS undertook an English language academic skills unit. Both units were facilitated by the introduction of an on-line learning management system (Cloudcampus).

This study examines the effectiveness of the interactive IMT technique and the assessment tasks used for the delivery of KNJ211 by comparison with the traditional, didactic style of teaching employed by the same teacher (first author) in the 2016. The synergy between the engineering unit and the English language unit (*Academic Skills Program*), delivered in the same six week period by the second author is also explored.

KNJ211 *Engineering Design and Project Management* was delivered (by the first author) to two cohorts of students studying Electrical Engineering and Automation and Communications Engineering over a six-week period in 2017. There were approximately 100 students in each cohort. The timetable for each cohort was 4 hours in a lecture room and 8 hours in a design studio each week. The teaching load for the UTAS teacher was 24 hours contact each week. Chinese university lecturers (third and fourth authors) were present in the class-room and design studio most of the time. All delivery was in the English language except for announcements (in the Chinese language) by the Chinese lecturers.

## Literature Review

### The challenge of teaching in China

Globalization has encouraged the emergence of large economies due to the fluid mobility of people, thus changing cultural patterns and diversity in higher education. According to the International Consultants for Education and Fairs, Australia hosted the greatest number of international students at higher education which provided (AUS) \$1 billion in 2014 (ICEF Monitor, 2015). For the past 20 years, full-fee paying overseas students have contributed a significant component of Australian universities' income (Dunn & Wallace, 2006; Wang et al., 2015). A considerable amount of research has been conducted looking at both undergraduate international students (Birrell, 2006; Burns, 1991; Malau-Aduli, 2011; Ramburuth & McCormick, 2001; Wong, 2004) and postgraduate international students (Wang & Shan, 2006), when transitioning to Australian universities especially from China.

Stereotypically, Chinese student learning styles are considered to be surface learning approaches where the student is a passive participant (Ramburuth & McCormick, 2001; Wong, 2004). But they adopt the methodology of learning by repeating and memorizing content for understanding. During the process they have the opportunity to reflect on troublesome content and devise methods to promote better understanding of instruction. These may include seeking assistance from the more knowledgeable other (Vygotsky, 1978), task analyzing complex concepts, and investigating vocabulary words to clarify the meaning of content. Thus they develop deep approaches in learning. The reflective nature of Chinese learners in developing a deeper understanding than what may be apparent from classroom participation is also documented (Wang & Shan, 2006).

The Chinese education system is designed to facilitate large classes. There are no disciplinary problems because they have been taught from young to respect their teachers

since the Confucius era (Guo & Pungur, 2008). Content is delivered in a manner that may appear to outsiders to be rote learning. But there are some misconceptions concerning the learning and study practices of Chinese students in Australia (Kember, 2000). Whereas Australian universities adopt the independent learner model, Chinese universities typically follow more of a parent-child relationship between the teacher and student (Wang & Shan, 2006). There is a strong peer support as well as access to teachers outside the classroom (On, 1996).

Doe, Jaikaran-Doe, Lyden and Wang (2016) surveyed newly-arrived civil engineering students in their first semester in the third year of a civil engineering degree at the University of Tasmania. The survey probed the students' experience of learning and teaching experience in China, in particular in the classes delivered in China by Australian academics. That study identified the different learning and teaching styles of the Australian teachers as being of most concern to students while they are still in China; but after coming to Australia it is their language that is of most concern - particularly understanding technical terms. In another study Ryan (2005) found that students encounter culture shock and academic shock at the beginning of their study in Australia. The delivery of engineering content using interactive Intensive Mode Teaching has the potential to assist these students with their transition to UTAS

## Methodology

The effectiveness of interactive IMT delivery was evaluated through students' performance in the following: summative assessment tasks aligned to the unit's Intended Learning Outcomes (ILOs); group-work video; fortnightly in class tests; and an individual assignment task (see Table 1). Participants were students enrolled in the second year of electrical power and communications engineering degrees at the Chinese university. Students' engagement with IMT was examined through the lens of the use of the on-line learning management system (Cloudcampus). Independent samples *t*-tests (with test for Normality) were employed to examine the significance of differences between students' results in 2016 and 2017. The level of student engagement in 2017 was the proportion of students who accessed the on-line student management system during the period the unit was delivered. There is no comparable data for 2016 prior to the introduction of Cloudcampus.

### Didactic learning and teaching in 2016 (teacher-centred)

The term didactic delivery is often used to describe the traditional learning and teaching practice in China. In 2016, prior to the introduction of an on-line learning management system (Cloudcampus) at the Chinese university, the unit KNE211 *Engineering Design and Project Management* was delivered (by the first author, assisted by the third and fourth authors) in the traditional teacher-centred style with the teacher delivering content knowledge from a raised dais in front of a blackboard to approximately 100 students sitting in rows of fixed seating. The available resources for teachers included a stationary computer, document camera, video projector, and a sound system. Slides, videos and the emphasis of important points by writing (with chalk) on a blackboard were the major delivery tools. Engagement with students was limited to those students who chose to sit in the front rows, and exhibited the best English.

### Intensive Mode Teaching in 2017 (student-centred)

The term 'student-centred learning' refers to a wide range of learning styles focussing on the needs and interests of students. Interactive Intensive Mode Teaching (IMT) techniques have been developed and successfully deployed in Australian universities (Male et al., 2016). The following IMT techniques were employed in the delivery of KNJ211 *Engineering Design and Project Management* at the Chinese university in May/June 2017:

- All lecture material was uploaded onto Cloudcampus before the start of teaching.
- In-class sessions were limited to four hours/week to maximise time in the design

studio.

- Content in the uploaded notes was **not** repeated in class (for example the explanation and function of the Raspberry Pi General Purpose Input/Output port, also programming in Python and the EV3 LEGO robot languages).
- An on-line formative assessment (Quizizz.com) preceded each fortnightly summative test, as was found valuable in a unit on critical theories of technological development and an intensive accounting unit delivered elsewhere (Crispin et al., 2016).
- Student engagement was encouraged both in-class and in the design studio through group competition.
- Time in-class was allowed for groups to discuss threshold concepts and report verbally or by writing on the blackboard.

### Intended Learning Outcomes

The following statement on ILOs was approved by the UTAS School of Engineering and ICT's Learning and Teaching Committee and included in the KNJ211 *Engineering Design and Project Management* Unit Outline:

On completion of this unit, students should be able to:

1. Demonstrate an understanding of the fundamentals of Engineering Design, Project Management, Engineering Ethics and Sustainability,
2. Develop and evaluate conceptual designs to address the problem specifications,
3. Function as an effective team member using simple project management tools to build and test a prototype design,
4. Critically reflect on your and others contributions to the team and the execution of the project.

### Assessment tasks

Assessment tasks for KNJ211 *Engineering Design and Project Management* delivered in 2017 comprised a group video report on the design-and-build component together with fortnightly in-class tests and a one-page, handwritten diagram (with explanation) of one of the micro-processor based circuits built and tested in the design studio.

Table 1 details the assessment tasks and their alignment to the unit's ILOs and Engineers Australia (EA) Elements of Competency for Stage 1 Professional Engineers (Engineers Australia, 2017).

**Table 1: Alignment and weighting of Assessment Tasks, ILOs and EA competencies**

Component	Weight	Due Date	Addresses ILOs	Addresses EA competencies
1. In class tests (Individual)	36%	Fridays weeks 2,4,6 in class	1.	1.3, 3.1
2. Circuit diagram (Individual)	14%	End of Week 6	2.	1.4, 2.1, 3.3
3. Project (Team)	50%	End of week 6	3. and 4.	2.4, 3.5, 3.6

## Engineers Australian Stage 1 Competencies

Graduates satisfying the Stage 1 competencies for professional engineers is part of the requirement for accreditation of engineering schools at Australian universities (anon, 2017). The competencies that the unit KNJ211 claims to deliver are listed below:

- 1.3 In-depth understanding** of specialist bodies of knowledge within the engineering discipline.
- 1.4 Discernment** of knowledge development and research directions within the engineering discipline.
- 2.1 Application** of established engineering methods to complex engineering problem solving. Vital aspects of an engineer's skill encompass design, innovation and project management. It is essential that an engineer can work within a framework of professional standards and yet have the innovative skills to produce creative design solutions. Students submit two team-work assignments.
- 2.4 Application** of systematic approaches to the conduct and management of engineering projects. Students develop an understanding of the fundamental concepts of engineering design, through studying the design of everyday artefacts as well as professional design practices. Students are introduced to contemporary concepts of innovation and project management within a competitive environment.
- 3.1 Ethical** conduct and professional accountability. Students are introduced to the Engineers Australia code of Ethics.
- 3.3 Creative, innovative and pro-active demeanour.** Students apply creative approaches in a design situation
- 3.5 Orderly management of self, and professional conduct.** Students have multiple tasks to prepare and report on a strict deadline with penalties for late submission. This necessitates prioritization given the requirements of other units.

## On-line learning management system

The Chinese university introduced an on-line learning management system (Cloudcampus) in time for the delivery of the KNJ211 Engineering Design and Project Management unit in May/June 2017. The Unit Outline and all lecture notes were uploaded two weeks before the start of teaching. Over each weekend the teacher uploaded the content to be delivered the following week with sections highlighted to show the threshold concepts which were to be discussed during the in-class sessions. In-class, the lecturer projected the content as a MS Word document (rather than PDF or PowerPoint) so other threshold concepts could be highlighted at the time if needed.

## Results

### Summative assessments

Table 2 shows a comparison of results for the summative assessments in KNJ211 *Design and Project Management* ( $N=186$ ) delivered in 2017 (using the IMT techniques) with the results of a similar cohorts ( $N=194$ ) who took the unit KNE211 *Engineering Design and Project Management* in 2016, delivered by the same teacher using teacher-centred, didactic teaching methods.

An independent-samples  $t$ -test was conducted to analyse the students' results.

*Cohen's d* was computed to identify and verify the magnitude of the differences between the means of the 2016 and 2017 results.

The overall result for the 2016 students ( $M=80.2\%$ ,  $SD=9.21\%$ ) was significantly better ( $p<0.0001$ ,  $t=-4.37$ ) than the results achieved in 2017 using the interactive IMT techniques. *Cohen's d* was 0.90 indicating a "large effect size". This result was unexpected.

Considering only the individual test results, which could be seen as a measure of the effectiveness of the interactive IMT delivery of content, the 2016 class ( $M=85.9\%$ ,  $SD=12.3\%$ ) performed significantly better ( $p<0.0001$ ) than the 2017 class ( $M=77.8\%$ ,  $SD=12.8\%$ ). With a *Cohen's d* of 0.645 this can also be considered as a "large effect size". The reasons for these unexpected results are explored in the Discussions section below.

The Design Project ( $M=70.4\%$ ,  $SD=10.4\%$ ) component in 2016 carried a 36% weight in the students' overall result and included a competition component in addition to the group video report. A design group's competition rank in the "LEGO Robot Rugby" competition and the "Chopsticks Tower" competition contributed to the group's Design Project mark. In 2017 the Design Project ( $M=75.7\%$ ,  $SD=8.46\%$ ) was weighted as 50% of the students' overall result. The change from 2016 reflected the introduction in 2017 of a Raspberry Pi based microcomputer design project in place of the "Chopsticks Tower" competition. There was no competition component in the 2017 Design Project assessment. By comparison the 2017 Design Project scored significantly higher ( $p<0.0001$ ) than the 2016 Project. *Cohen's d* = 0.56 indicates a "medium effect size" for this result.

The relatively low result ( $M=50.0\%$ ,  $SD=29\%$ ) for the individual, hand-drawn circuit diagram is a contributing factor to the low overall result in 2017. By contrast the equivalent individual assessment component in 2015 (a portfolio) achieved a uniformly high result ( $M=69.3\%$ ,  $SD=3.5\%$ ). The hand-drawn circuit diagram was introduced in 2017 to encourage individuality.

**Table 2: Components of students' overall performance.**

Assessment Task	2016		2017	
	Mean (%)	Standard Deviation (%)	Mean (%)	Standard Deviation (%)
In-class tests	85.9	12.8	77.8	12.8
Design Project group video report	70.4	10.4	75.7	8.5
Circuit diagram	n.a.	n.a.	50.0	29
Overall result	80.2	9.2	71.7	9.6

## Discussion

### Student-centred versus teacher-centred learning and teaching

Segers & Dochy (2010) comment that whereas teachers and students are moving towards new learning environments and modes of assessment acceptance is not a simple process, particularly for problem-based learning. In a study involving non-Chinese teachers of English at a Chinese University, Wang (2011) found '*Chinese students expect that the teachers' role is to transmit information rather than engage students in dialogue and challenging students to think*'.

Feedback from one student on the trial conducted (by the first author) of IMT techniques in a final year engineering unit at UTAS in March 2017 suggested that the expectation of students was for a lecturer to "teach" them. (P.Doe personal communication 30 June 2017). The focus of student-centred learning is for the students to "learn" rather than be taught. If a final year engineering student in Australia wants to be "taught" it could be that the acceptance of IMT in China would be problematical considering Chinese students history of didactic

learning. It may also be that interactive Intensive Mode Teaching techniques have only recently been introduced in the delivery of engineering units at UTAS and elsewhere. Students develop an expectation based on their prior years of study and when something different is introduced they are resistant.

### **Technical English fluency**

Teaching and learning in the design class was constrained by students' lack of technical English fluency. Most students did not know the English word for "screwdriver". A student in the design studio looked blankly when the teacher offered to "fix" a problem with a motor-driver. Other students chose to download Chinese language versions of software making instruction by the UTAS teacher difficult. Lack of English fluency has been shown to be the major factor in Chinese students' poor performance in their first semester in Australia (Doe et al., 2017). It is possible that students' ability to read and understand the content uploaded in English to the on-line learning management facility is also a limiting factor in the effectiveness of interactive IMT in China.

### **On-line learning management system**

The interactive IMT delivery is critically dependent on students accessing course material uploaded in advance to the on-line learning management system (Cloudcampus). This system was introduced to the Chinese university towards the end of 2016 with the result that students had not developed a culture of accessing and interacting with Cloudcampus. Even though both the engineering content and the English language teachers stressed the importance of regularly reading postings on Cloudcampus only 45% of the students enrolled in KNJ211 *Engineering Design and Project Management* accessed the information in Cloudcampus. However it should be noted that Chinese students enjoy strong peer support through living together on campus. Content downloaded from Cloudcampus could have been shared.

### **Synergy with English language program**

During the 2017 delivery of the content KNJ211 *Engineering Design and Project Management* there were instances where synergies in the form of students' use of vocabulary from their *Academic Skills Program* occurred. As an example - in the delivery of content on Engineering Ethics the teacher identified 'bias' as a threshold concept. After allowing a few minutes for the design class groups (8 students in each group) to discuss the concept, the teacher handed the chalk to one of the students who wrote an example of 'bias' on the blackboard. The student wrote: "An example of bias could occur at a job interview when the applicant was not appointed on the basis of race". The teacher was surprised by the vocabulary until it was pointed out that students had participated in mock interviews in their *Academic Skills Program* class by the second author.

### **Formative assessments**

A mobile phone or personal computer based quiz, *Quizizz* ([www.quizizz.com](http://www.quizizz.com)) was used as a formative assessment in both the students' engineering and Academic Skills program language classes. A *Quizizz* test was set as homework in KNJ211 two days before each of the in-class, paper-based, fortnightly (summative) tests. Likewise *Quizizz* tests were used in the *Academic Skills Program* as a formative test of students' technical vocabulary. Access details for the *Quizizz* website ([join.quizizz.com](http://join.quizizz.com)) were displayed in the design classes. Because *Quizizz* is voluntary and anonymous it is not possible to assess its effectiveness as a teaching and learning tool. However the response rate for the three *Quizizz* tests in KNJ211 (222, 145, 113 attempts respectively) is some indication of their effectiveness in encouraging student engagement. Several students questioned the teacher on items in the *Quizizz* tests.

In September this year the principal author delivered a different unit KNX240 Reliability Engineering at another Chinese university. Based on the experience with delivering

KNJ211 earlier in the year using *Quizizz* the quiz facility in Cloudcampus was used for a formative assessment at the end of week 1. This had the desired effect: all enrolled students logged into Cloudcampus in order to participate in this assessment.

## **Summative assessments**

### *In-class tests*

Individual, written, tests (worth 36% of the final mark) were conducted in-class on the second, fourth, and the last Friday of the six-week teaching period. In KNJ211 delivered in 2017 the first two tests comprised 12 statements written in simple English requiring a TRUE/FALSE response. For example: 'Crashing a project means that it has failed' (FALSE). The final test was multiple choice modelled on the *Quizizz* formative tests. All in-class tests were designed to assess students' understanding of content rather than their proficiency with writing. Tests were not conducted with the same attention to individuality as with formal examinations in Australia. In one class there were 113 students sitting beside one another in the class-room. It was evident from marking that some students had compared answers despite the attention of two invigilators.

### *One-page hand written circuit diagram*

This assessment was introduced in 2017 to assess a students' contribution to the design-studio group work. The handwritten requirement was intended to prevent photocopying or copy/paste of other students' submissions as had occurred with a portfolio assessment in the same unit in 2015. This strategy was only partly successful; students were observed copying others' reports in the hour leading up to the deadline. The low mark for this task (M=50.0%, SD=29%) may reflect students' expectations that their video project mark together with their test aggregate mark would be sufficient for a pass grade in this unit. Only two of the students presented drafts for the teacher to review before submission despite repeated invitations.

### *Group video reports*

Video reports have been used for summative assessment in *Engineering Design and Project Management* units at the Chinese University every year since 2014 also in 2015 at UTAS when the same teacher (PD) delivered the same unit (but with a different unit code). The incentive for this form of assessment was a workshop on *digiExplanations* conducted by Hoban (2013) from the University of Wollongong. This form of assessment is particularly suited to the delivery of a design and project management unit in China. It minimises the emphasis on written English skills by students whose English is a second language. Producing a high-standard 5 minute video within a three to six week time frame is a project in itself, given the students had no previous experience in video production.

Recently there has been discussion within the School of Engineering and ICT at UTAS on the merits of a group video as a major (50%) component of the assessment in this and other units on-shore and off-shore. On-shore, some students have expressed their dislike of group presentations (not just video reports) as they feel that members of the group either can-not or do-not contribute with the result that the individual's mark does not reflect their ability or effort. This also applies in some extent to group laboratory reports on-shore.

The ability of a group video report to assess Intended learning outcome in KNJ211, namely "Critically reflect on your and others contributions to the team and the execution of the project", was challenged by a UTAS L&T committee member. In defence, the group video report the assessment rubric (for a High Distinction mark) requires that "The video describes the roles and contributions of all the team members". However at the other (Pass mark) end of the scale the requirement is only "The video contains only the names of the team members".

## Conclusions

Notwithstanding the authors' enthusiasm and initiative in embracing student-centred learning and interactive IMT techniques, the effectiveness of delivery of the **KNJ211 Engineering Design and Project Management** at the Chinese university in 2017 (as measured by students' results) was disappointing.

This experience further confirms the authors' observations that Students' technical English language skills present a challenge to effective delivery of engineering content.

However some IMT techniques proved to be effective as evidenced by students' in-class participation in the discussion of threshold concepts.

The University of Tasmania is in the process of revising the curriculum for its Bachelor of Engineering with Honours Degree. The revised curriculum includes a significant component of experiential, project based learning and design project across all specialisations. If student-centred learning and teaching is to be embraced in the new curriculum it is vital to explore further the reasons for the disappointing results from this introduction of interactive Intensive Mode Teaching in China.

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