Study and practice of joint teaching between ZJU and UWA

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ABSTRACT

A joint international unit on dynamics, vibration, and sound was established in early 2014 for engineering students in their penultimate year at Zhejiang University (ZJU), China, and at the University of Western Australia (UWA), Australia. The unit was taught entirely in English. Dynamics and sound topics were taught live to ZJU students and vibration topics live to UWA students. Recordings were uploaded to websites so that students at each university could access the material. A set of quiz questions supplemented each recorded lecture. Tutorials and laboratory practical classes (weighted 15%) were delivered using a combination of live teaching/demonstrations and self-learning via online recordings. A group project (weighted 25%) using receptance encouraged students to self-study three chapters of an e-book on vibration. Additionally, it provided an opportunity for teamwork, internet forum discussion, computer programming, and optimization. Apart from the final exam (weighted 60%)—conducted simultaneously at each university—all assessments were completed online. This paper summarizes some key observations of the effects of various teaching methods on the students' effort and performance at the two universities. In addition, it highlights the need for integrated live lectures, online support, and a variety of practices for effective knowledge and skills transfer.

Keywords: Joint teaching, dynamics, vibration, sound I-INCE Classification of Subjects Number(s): 07

1. INTRODUCTION

The study of new teaching methods and their effects on the performance of tertiary students has been in high demand in the last decade. This is because of: 1) the increased student-to-professor ratio, the increased research-to-teaching-time-ratio of professors [1], and the reduced available time of students for each unit; 2) the availability of high-quality web-based teaching units and modern communication methods; and 3) the internationalization of education. As a result of such demands, universities have made substantial investments in the development of modern teaching methods and best teaching practices. Centers for teaching and learning are now found in many universities. Various kinds of funding have been made available to support the research and development of novel teaching methods and practices. Enterprises have also recognized the commercial value of modern teaching contents and methods.

The study and practice of joint teaching reported in this paper were undertaken as a result of a demand for a joint teaching program between Zhejiang University (ZJU), China, and The University of Western Australia (UWA), Australia. ZJU and UWA have been sister-universities for more than a decade and have already established several links in research and education. ZJU is interested in establishing joint teaching units owing to needs for: 1) teaching entirely in English some units at senior levels of undergraduate teaching and 2) utilization of the most recent teaching materials and best professors for a subject. The drive behind those needs is the goal of increasing its place in the Academic Ranking of World Universities [2] by providing students at ZJU with the best available

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resources for a subject and enhancing their ability to study in English-speaking and overseas environments. In implementing joint units, UWA is interested in: 1) demonstrating and providing UWA's excellent teaching to the world and to attract the best students at ZJU to the postgraduate research program at UWA, 2) increasing UWA students' awareness of overseas job and research opportunities, and their international links with graduates in their own discipline, and 3) exploring the undergraduate teaching market in China.

This study compares: 1) Face-to-Face Live Lectures (FFLL) and Learning From Recorded Lectures (LFRL); 2) effectiveness of live and recorded tutorials, laboratory practices, and online quiz questions; and 3) the performance of students at ZJU and UWA against the same teaching arrangements and assessment criteria, but with different language and professional training backgrounds.

2. MATERIAL DELIVERY

Professors, assistant professors, and tutors for the joint unit on dynamics, sound, and vibration (DVS) between ZJU and UWA were involved in the design and teaching of the lectures, tutorials, laboratories, exercises, and assignments of the unit. The main form of material delivery was via lectures.

2.1 Lecture formats

The teaching of DVS involved lecture presentations over eight weeks from 24th February to 18th April 2014, with four lectures each week. The subjects of dynamics and sound were taught at ZJU (two lectures/week) via FFLLs, and the recordings were made available on both the ZJU and UWA websites. Vibration was taught at UWA (two lectures/week) via FFLLs, and its recordings were also sent to the ZJU and UWA websites. The recorded lectures and associated lecture handouts, scanned hand-notes, and eBooks [3] on the websites were for those students who did not have chance to attend the live lectures and those who wanted to re-study the lectures. The recorded lectures included all the teaching information displayed on the lecture screen, and some of the recorded lectures also included the view of the lecturer. Figure 1 shows the weekly timetables for the FFLLs and LFRLs. It shows that the transfer time of the recorded lectures at ZJU to UWA on every Tuesday must be less than 3 hours. Classrooms and times were allocated for both ZJU and UWA students to attend the recorded lectures, where assistance from both tutors and professors was available.

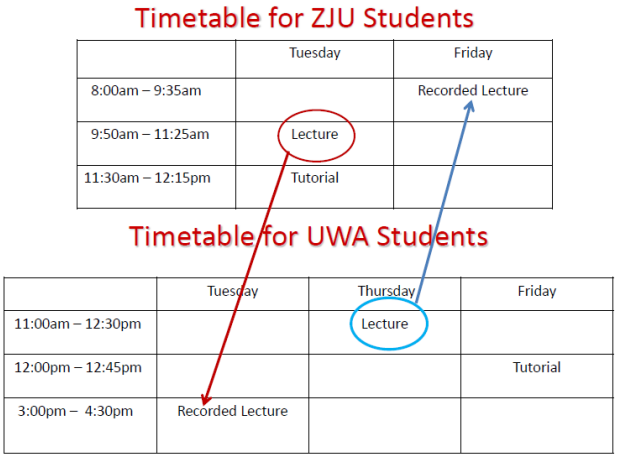

Figure 1 – Weekly timetables for ZJU and UWA students.

Figure 2 is a flowchart showing the transfer of the recorded lectures. It is worth mentioning that ZJU has a small dedicated teaching support team for recording and editing live lectures, while the lectures at UWA were recorded by the automatic Lecture Capture System (LCS). The transfer of recorded lectures to the teaching/learning management system was via the Baidu cloud and the average transfer time for 90-minute-long lectures was 4–6 hours. As a result, UWA students could only have some of the recorded lectures at their recorded lecture sessions (for this reason, UWA's recorded lecture sessions were only held in the first week of the semester). Their main access to the subjects of dynamics and sound was through self-learning of the recorded lectures on UWA's Learning Management System (LMS) website. Meanwhile, adequate time between the live vibration lecture and the recorded lecture session allowed ZJU students to attend all the recorded lecture sessions, where

explanations of the recorded lectures saved much of their time for self-learning of content.

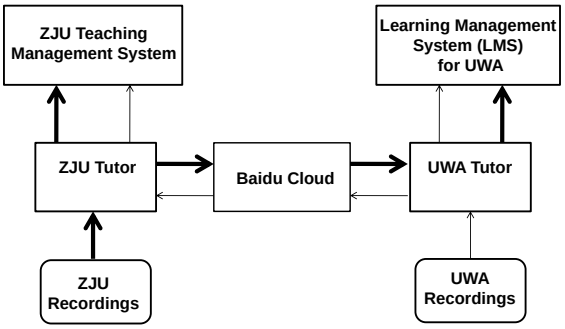

Figure 2 – Flowchart showing the transfer of recorded lectures.

In the FFLLs, the professors were able to demonstrate derivations of the lecture material and adjust the pace of the lecture based on questions and student responses. During the FFLLs, a clear voice and views of the projected graphs were ensured and students could be fully engaged. However, a time commitment (including traveling and pre-lecture preparation) by both teachers and students was required. On the other hand, the LFRLs provided a way to gradually improve the quality of web-based recorded lectures and teaching materials, so that live lectures can be a part of future teaching and can concentrate on the discussion of recorded lectures and on providing new updates of the subject. Indeed, study of the recorded lectures is not restricted by time and location. If used by efficient self-learners, then irrelevant and familiar lecturing materials in the recording can be skipped, resulting in a more efficient use of time for learning and teaching.

Fifty-five students from ZJU were enrolled in the unit. They were third-year students in the Department of Scientific Instruments. Although they had some basic training in general physics and mathematics, their main area of training was in computer hardware, software, and signal processing. The students' loading at ZJU was six units within eight weeks. DVS was an elective unit. They were capable of some simple daily English. Most of the students needed to use dictionary for the technical English used by DVS. Meanwhile, 142 UWA students were enrolled in the unit. They had the pre-requisites in general physics and mathematics. The average loading of the UWA engineering students was four units per semester (thirteen weeks) and DVS was one of their core units.

The percentage attendances of the students from both universities at live lectures are shown in Figure 3. The general trend of these attendances follows the expected patterns. The first lecture always attracts the most students, which indicates the importance of the first lecture in students' perception. There was a sudden increase in student attendance at the last lecture at ZJU, which may be explained by the students' interests in the final summary and exam information. There is no significant increase in attendance at the last lecture at UWA; however, visits to UWA's teaching website, shown in Figure 4, increased dramatically in the week after the last lecture. Between the first and last week of teaching, the average attendance at ZJU was 55.8%, and that at UWA is 46.5%, indicating that approximately 50% of the students did not attend the live lectures.

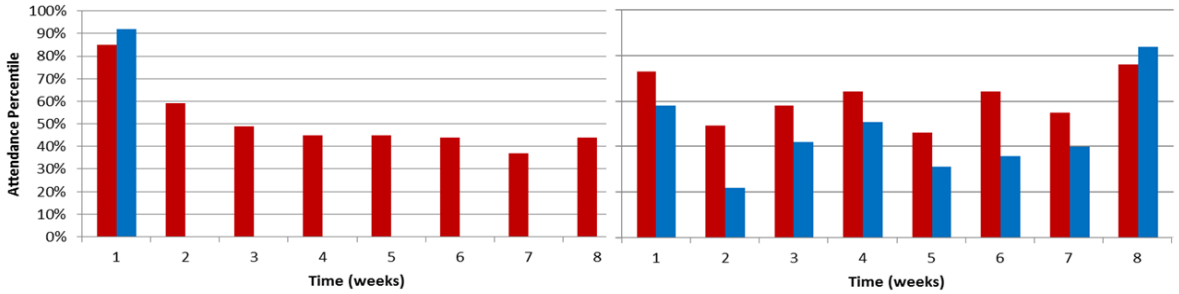

Figure 3 – Percentage attendance of the weekly live and recorded lectures at UWA (left) and ZJU (right). Live-Lecture, red; Recorded-Lecture, blue.

Although UWA's LMS website was open to all students enrolled in the unit, visits by ZJU students to LMS were limited by the slow web speed. As a result, most of the teaching materials,

except for quiz questions, discussion forums, and lab questions, were made available at the ZJU teaching and learning website. Therefore, the large number of visits to the UWA website demonstrates that the UWA students heavily relied on website-based learning for their study. The large number of visits to LMS is consistent with the low attendance percentage at UWA and the requirement for web-based learning of the dynamics and sound topics and of the chapters of the eBook. The small number of visits to the web-based learning system at ZJU may be due to the following reasons:

(1) Web based learning is a relatively new experience for them. It is likely that they need some time to adapt to it;

(2) The teaching and learning website was not fully set up until week 3 of the semester;

(3) Hardcopies of the eBook and summaries of lecture notes were made available to every ZJU student; and

(4) ZJU students had the opportunity to attend the recorded lecture sessions each week.

The observation also suggests that the students at ZJU were not yet familiar with using the website as a learning system, and that their method of learning was mainly based on FFLLs and the handouts of lecture materials.

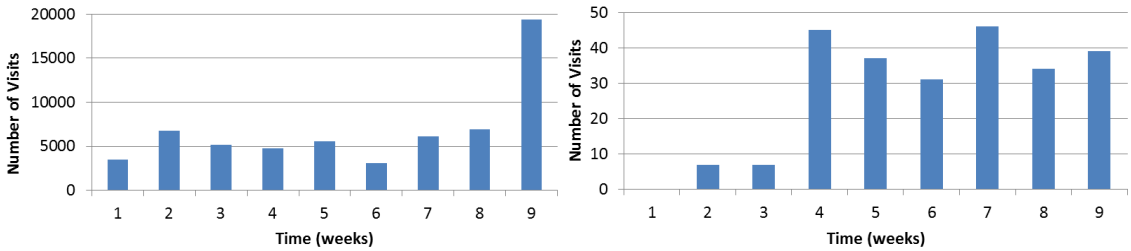

Figure 4 – Number of visits to the teaching websites for: a) UWA (left) and ZJU (right).

The results of a mid-semester survey, shown in Table 1, demonstrate that the majority of students at UWA could easily navigate the LMS website for their learning, while only 40% of the ZJU students could use the website. More than 50% of the ZJU students did not express their opinions, indicating possible barriers in using LMS (as the assessment was conducted in the UWA LMS). It may also be a reflection of cultural differences around giving feedback/criticism to academic staff. It is clear that a majority of students from the sample indicated that attending live lectures was more suitable for studying this unit, and most of the students from this small sample pool preferred traditional units (in which they attend classes) than online units.

These results demonstrate that the preferences for FFLLs and LFRLs are divided. On the one hand, a group of students (~40–50%) indicated a definite preference for having live lectures. However, the evidence of 50% UWA and 40% ZJU attendance at live lectures indicates that the remaining students are dependent on recorded lectures and online teaching. The mid-semester student feedback also allowed adjustments in: 1) emphasizing the unit requirements and deadlines (as a significant percentage of ZJU students were not aware of them); and, 2) ensuring that ZJU students could access the online material at their local website.

Table 1 – Mid-semester student feedback (sample size: UWA 41, ZJU 15).

	UWA			ZJU		
	Agree	Neutral	Disagree	Agree	Neutral	Disagree
I find it easy to navigate the LMS website and find resource materials (*i.e.*, the recorded lectures, tutorials, laboratories, and handouts).	86%	7%	7%	40%	53%	7%
I find that attending live lectures is more suitable for studying this unit.	73%	15%	12%	73%	20%	7%
I find that watching recorded lectures is more suitable for studying this unit.	29%	25%	46%	13%	54%	33%
I prefer an online unit to a traditional unit (attending classes).	15%	24%	56%	7%	46%	47%

3. MECHANISMS FOR FACILITATING UNDERSTANDING

Two forms of continuous application of knowledge were used provided so that students could apply lecture content to problem solving. These were a single full class tutorial each week and supplementary online quizzes.

3.1 Tutorials

One tutorial session, in the form of face-to-face teaching, was arranged each week at each university. At ZJU, the session was for dynamics and sound, while at UWA the session was for vibration. Recorded tutorials were also made available online. The attendance percentage of tutorials has a similar pattern to that of lectures. The percentage value at ZJU was more than 10% higher than that at UWA and likely due to the tutorials at ZJU being immediately after the lecture sessions. Tutorial sessions were allocated to practice problem-solving skills and encourage student questions. Compared with traditional small classroom tutorials, the tutorial sessions for the whole class are a significant saving in time and resources. Because the tutorials were conducted by the same professor who delivered the lectures at ZJU, and by an experienced assistant professor at UWA, the consistency and quality of the tutorials were maintained. The same amount of tutorial material was covered and there appeared to be no objections to such large classroom tutorials.

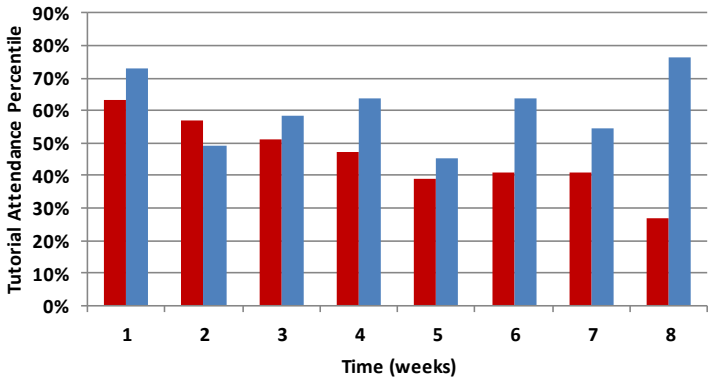

Figure 5 – Tutorial attendances by ZJU and UWA students. UWA, red; ZJU, blue.

3.2 Quizzes

A set of web-based quiz questions were provided after each recorded lecture. These quiz questions were exercises for enhancing the concepts and methods discussed in the lecture. The purpose of the quiz questions was to help students' understanding of the lecture material. Students were allowed multiple attempts to answer the questions, and correct answers and explanations were displayed after the students made their attempts. Web records indicated that the quiz questions were extensively visited by UWA students, indicating their effectiveness in web-based learning. However, only a few ZJU students attempted the online quiz questions in the LMS.

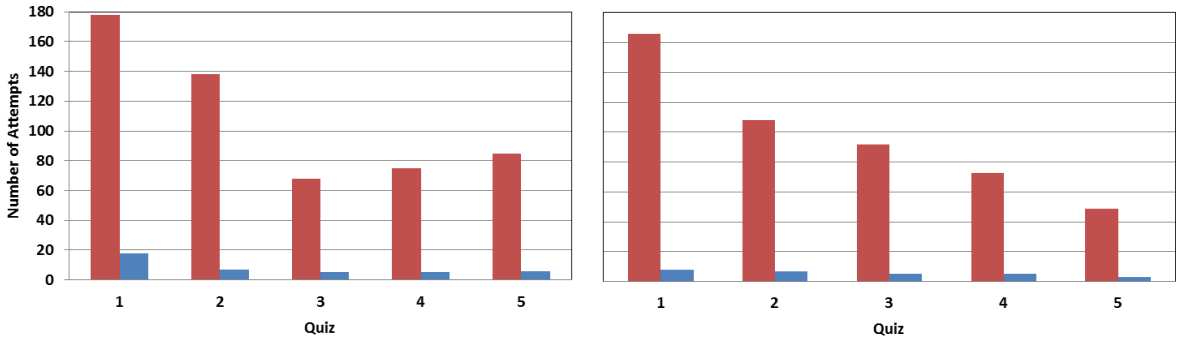

Figure 6 – Number of attempts to answer the quiz questions on dynamics and sound (left) vibration (right). UWA, red; ZJU, blue.

4. ASSESSMENT MECHANISMS

Assessments were designed and used for the evaluation of the performance of students, teachers, and supporting teams, and the effectiveness of the various teaching methods. Feedback mechanisms, including mid-semester assessments, classroom consultation, and unit website communication, were used to adjust various parts of the teaching. The three assessment mechanisms involved two laboratories, an assignment and an exam.

4.1 Laboratories

This unit included two laboratory sessions: Lab 1 was on the transverse vibration of a cantilever beam, and Lab 2 was on sound waves in a pipe. Each lab was worth 7.5% of the unit total. Two sessions at each university were devoted to classroom demonstrations of the two laboratory practices (see Figure 7). In particular, at ZJU, students were invited to the teaching platform and performed part of the measurement while the lab demonstrator explained it. The recorded lab demonstrations and recorded data were made available for students to use as they used the LMS to complete an online laboratory report (including signal processing, analysis of experimental results, and error analysis). Students were also encouraged to come to the laboratory to conduct the experiments and tests on four allocated afternoons. These non-compulsory hands-on lab practices offered opportunities for students who were interested in using the equipment and making measurements. At UWA, 34% of students attended the first hands-on lab and 15% attended the second hands-on lab. However, no students at ZJU attended the non-compulsory hands-on lab sessions. All the students used the LMS to complete and submit their lab reports. Table 2 provides a summary of the assessments of the laboratory practices. The average marks for the laboratory practices of the UWA students are higher than those of the ZJU students. A comparison of the distributed lab marks between the two groups of students (see Figure 8) shows that the majority of students with higher marks (6–7.5) are UWA students, which is well correlated to the efforts made by the UWA students in participating in the non-compulsory hands-on lab practices.

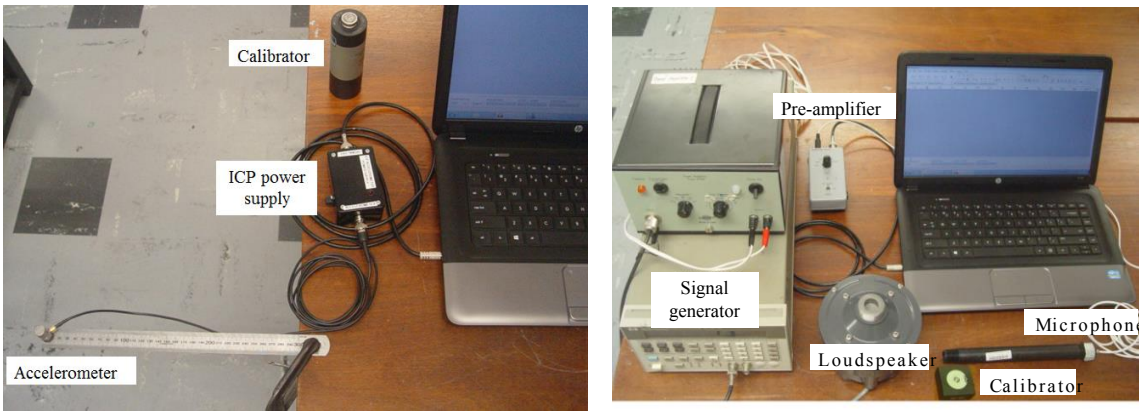

Figure 7 – Laboratory set-ups for Lab 1 transverse vibration of a cantilever beam (left) and Lab 2 sound waves in a pipe (right).

Table 2 –Average marks for web-based laboratory submissions (each lab was out of 7.5)

	UWA			ZJU		
	Average	Median	Standard Dev.	Average	Median	Standard Dev.
Lab 1	5.63	5.66	0.99	3.88	3.89	1.50
Lab 2	6.43	6.72	0.75	4.88	5.73	2.18

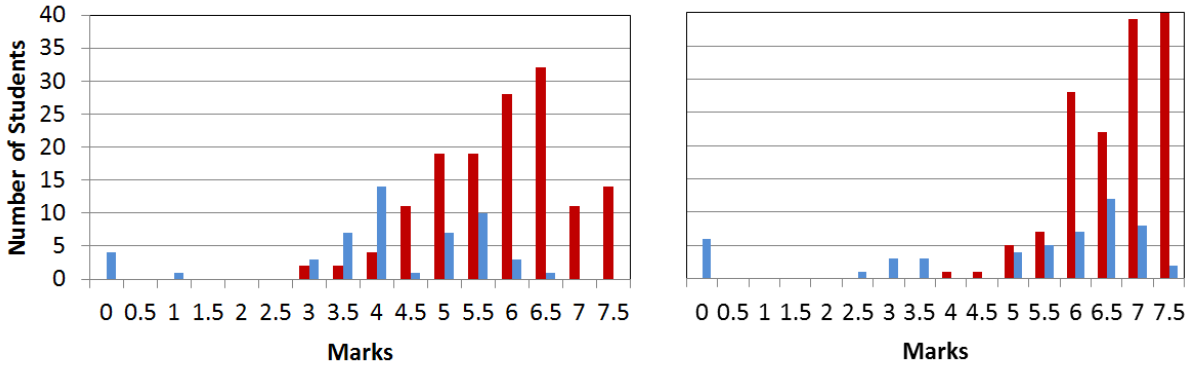

Figure 8 – The mark distribution of the two laboratory practices (Lab 1, left and Lab 2, right).

UWA, red; ZJU, Blue

4.2 Assignment

To encourage self-learning, teamwork, and solving practical problems, a large portion of the unit (25%) was devoted to an assignment project, shown in Figure 9. Each student was placed in a team of three or four and each team was given different values for the relevant parameters (L_1, D_1, D_2, and α). Their aim was to improve the transverse vibration response (at its free end) of a cantilever bar (undamped) with a square cross-section ($D_1 \times D_1$), by using a second smaller bar of rectangular cross-section ($D_1 \times D_2$) and some damping material. The damping material had a stiffness characteristic $k(1+i\alpha)$, where k is in Newtons per meter and α is the hysteretic damping ratio. A team report (less than 1000 words) was required to include the analysis, optimization, method, and results including the optimized response and the values of k and L_2.

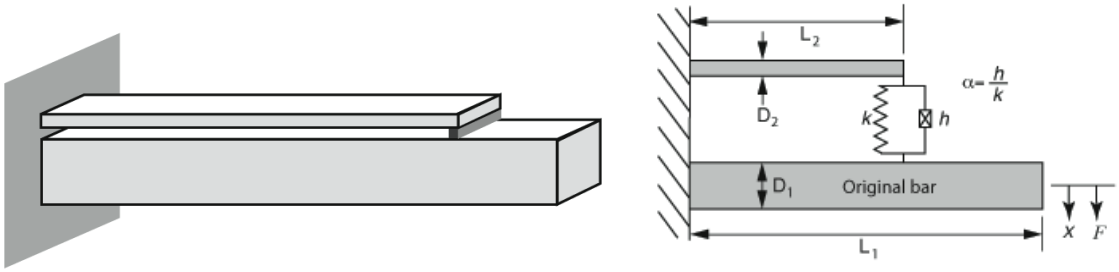

Figure 9 – The vibration control problem used for the assignment in the unit.

Solving the assigned problem shown in Figure 9 required a substantial effort by each team. Students were instructed to self-learn three chapters of the eBook [1]. An optimization program for parallel solid bars of equal length and the derivation of driving point receptance of coupled bars were given as examples to the students.

The students' efforts to solve the assigned question could be observed from student questions and after-lecture consultations:

(1) Understanding the receptance concepts and derivation of the driving point receptance based on the receptances of component structures were time-consuming tasks and usually required several weeks' effort;

(2) When complex technical concepts were mixed with difficulties in technical English, the non-English speaking students faced additional challenges (particularly in regard to interpreting quiz, assignment and exam questions – as reflected in their marks);

(3) MatLab programming and optimization did not take the ZJU students much effort once the correct receptance expression was obtained. However, writing the team reports appeared to be a great challenge for the ZJU students as they were hardly trained for such tasks.

(4) At each university, there were some teams that displayed extraordinary dedication and effort towards completing the assigned project. They were generally the teams that gained the better marks.

Table 3 compares the average assignment marks of the ZJU and UWA teams. The results indicate a need for training of ZJU students in two areas: technical English and scientific reporting in English. These two areas of training are routine and implicit for UWA students.

Table 3 – Average marks (out of a total of 25 marks) for the group assignment.

UWA			ZJU		
Average	Median	Standard Dev.	Average	Median	Standard Dev.
22.34	22	2.47	16.4	18	5.57

Figure 10 shows the distribution of assignment marks of the UWA and ZJU teams. It is worthwhile to note that the fewer students at ZJU make their results appear worse than those at UWA, upon first glance at Fig. 10. The peak for UWA students is located at the top mark, while the peak for ZJU students is located close to 17.5/25. Nevertheless, several teams from ZJU still reached the top performance, indicating the possibility of ZJU students achieving the top assignment standard at UWA.

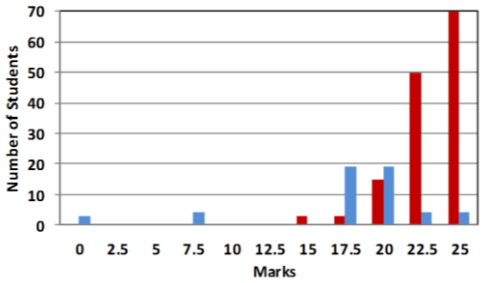

Figure 10 – Distribution of assignment marks of UWA (red) and ZJU (blue) students.

4.3 Exam

At the end of the condensed teaching period both cohorts of students sat the same exam which was worth 60% of the unit mark. To ensure that both cohorts were subjected to the same conditions and to avoid plagiarism between universities, the exam was set on the Saturday one week after classes for the unit finished. The exam comprised 6 questions from which students chose 5 to attempt. The raw exam results are depicted in Figure 11 below. It is apparent that the larger class size at UWA resulted in a more normal distribution of marks with an average of 53.2. The average at ZJU was slightly lower at 47.1 – skewed by the four students who obtained a mark of zero. Both cohorts had students who received marks above 80%. It may be noted that, unlike an assignment which requires a report, exam type solutions tend to be numerically based and hence it seems students were able to convey their understanding in such a context.

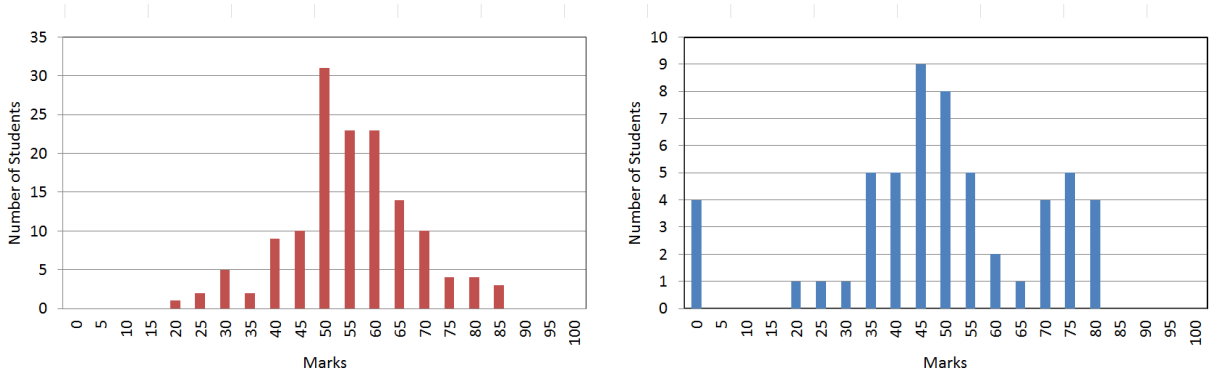

Figure 11 – Distribution of exam marks of UWA (left) and ZJU (right) students.

5. SUMMARY

The joint teaching effort between Zhejiang University (ZJU) and the University of Western Australia (UWA) achieved the original objective, listed in the Introduction, of both universities. A

study of the teaching provided some useful information for the more effective practice of such joint teaching:

(1) Only 50% attendance at live lectures demonstrated the need to develop quality web-based recorded lectures, and to provide sufficient support to self-learning.
(2) Large classroom tutorials and lab demonstrations, integrated with web-based recordings and support appeared to be effective.
(3) Extra-support non-compulsory hands-on laboratory practices (in short periods) were attended by a significant percentage of UWA students, which might have led to the higher quality in laboratory reports by those students.
(4) Students' performance in the joint unit was not only dependent on their effort during their study of the unit, but also strongly correlated to their training in their previous studies. For example, a rigorous training in software engineering gave ZJU students an advantage in completing the programing section of the assignment. However, a lack of systematic training in technical English and scientific reporting posed a serious barrier for ZJU students to effectively cope with the requirements of the joint unit.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the financial support from ZJU and the Faculty of Engineering, Computing and Mathematics at UWA for teaching and laboratory demonstration equipment and printing costs for ZJU students. The support from Center for Modern Education Technology of ZJU and the Center for the Advancement of Teaching and Learning of UWA are also gratefully acknowledged.

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