Linyi - Cambridge Summer School 2009 - Report

The Linyi - Cambridge Summer School 2009 took place during the week 8 - 14 July, at Linyi Normal University in Shandong Province, China. Thirteen postgraduate students from Cambridge University gave four days of lectures on topics mostly taken from the Part II and Part III courses at Cambridge. The days of lectures were followed by a day for our Chinese students to review and prepare for the final day, during which the Chinese students gave presentations on the course material. The project included three days of preparation and teaching practice in Cambridge in mid-June and a week of intensive language training and cultural background in Linyi before the Summer School week.

The stated aims of the project were the following:

-to give students in Shandong the experience of the student-led seminars which are so much a part of our mathematical life here in Cambridge,

-to stimulate a research culture within Shandong Province,

-to encourage networking both between UK students and Shandong students, and amongst Shandong students,

-for our Asian students, to explore means of serving their home countries even while they are studying/working abroad,

-for our Western students, to give them an experience of life at Chinese universities.

It is to the very great credit of all who took part that the project met and surpassed these goals in every respect. The Chinese students responded with enthusiasm to a style of teaching which involved the audience in an active role. As a consequence the mathematics department at Linyi is now considering ways of incorporating this style of teaching as a part of its teaching practice. The degree to which our students began socialising with their Chinese students even in the short time they were together augurs well for continuing interaction. While I would like to have seen a greater representation from other Chinese universities, there is anecdotal evidence that this networking is happening and is useful. Certainly e-mail addresses have been exchanged both between Chinese students studying at different universities, and between Cambridge students and summer school students. Our Asian students played a mission-critical role in the running of the programme, and have become very involved in the planning and design of future projects. While the summer holidays may not present Chinese university life in its entirety, the close interaction between our students and their Chinese students serves to complement our students' experiences during their two weeks on campus, leaving them with a good working understanding of life in a Chinese university.

We went to Linyi to teach, but we seriously underestimated how much we ourselves would learn in the course of the project. The summer school presented us with the double challenge of designing courses appropriate to students from a different mathematical background and learning in a foreign language. Together with the summer school ethos, where the aim is that the entire class should be able to grasp the ideas in the course, this challenge stimulated much critical and productive thought about teaching methods and techniques. Pedagogical ideas developed during the course of this summer school will certainly be applied in future editions of the summer school, and may well be adapted for

use during the school year within the mathematics curriculum at Linyi. We will be applying some of these ideas in Cambridge to improve our teaching support for the Part III mathematics tripos.

The success of the project is such that we are expecting to repeat the project next year at Linyi, and are considering ways to extend the project. Next year's teachers will include students from Oxford and possibly Warwick as well as Cambridge. Running similar schools at other universities in China, and running schools on subjects other than mathematics are also being discussed.

1.**The project**.

1.1.**History of the project**. Linyi Normal University serves a largely agricultural area in Shandong Province. The institution was founded in 1941, and had an initial purpose of supplying teachers for the region. My first visit to Linyi in 2006 was motivated by a desire to practice my elementary Mandarin. On discovering that I was a mathematician, Linyi staff invited me to teach mathematics instead. I discovered that in spite of fairly humble academic ambitions, the classes included a core of able students who would profit from a more ambitious programme, a department eager to adopt measures which would facilitate this, and a university leadership absolutely committed to raising the institution's academic standing. Following that visit I began discussing measures that might be made to give able students a chance to progress further, and to begin to develop a research culture with members of the mathematics department. The possibility of bringing over some students from Cambridge to run a summer school was one of these measures. At the same time, within the mathematics departments at Cambridge, as part of the Transferable Skills Training programme, we have been exploring ways of

giving our PhD students opportunities to teach and mentor the Part III students. We have also seen the Part III students responding and developing their own capacity to teach, encourage each other and collaborate. The challenge was to adapt these experiences to the Chinese pattern of higher education. I believe that the spirit behind the methods that have been effective here at Cambridge can equally be adapted to developing universities as a means of achieving the goal of offering Chinese students even from rural backgrounds the chance of achieving their mathematical potential.

1.2. **Project Schedule**.

1.2.1.**June 10 - 12** Course preparation workshops in Cambridge.

1.2.2.**June 29 - July 8**. Language training and course preparation in Linyi.

1.2.3.**July 9 - 12**. Summer school. Classes met each day, with a two hour teaching session complemented by an hour of helping students work through examples.

1.2.4.**July 13**. Preparation day for the mini-conference on the 14th.

1.2.5.**July 14**. Chinese tudents taking part gave short talks reviewing the material of the course and presenting interesting examples.

1.2.6.**July 15**. Programme evaluation and final meetings with the leadership of the Linyi Mathematics Department.

1.2.7.**July 15 - 22**. Cambridge students departed for independent travel in China.

1.3.**People**. This year's project involved thirteen students. Five of them, James Cooper, James Griffin, Ta Sheng Tan, Qing Wang, and Hui Guo are presently research students, all in DPMMS, with Hui Guo and Qing Wang members of the Statslab. Qing works with the Medical Research Unit at Addenbrookes Hospital. Two students, Matthew Tointon and Peng Zhao will be joining DPMMS and DAMTP respectively as research students in October. The remaining six, Dean Bodenham, Martin Gould (starting a PhD at Oxford next year), Patrick Orson, Dale Winter (starting at MIT next year), Lloyd West (starting at Purdue next year) and Barinder Banwait (starting at Warwick next year) had just completed Part III. We were accompanied by Lori Colliander, secretary in DPMMS, who took charge of logistics, and whose experience in running student programmes in other universities has been extremely useful to us in planning and in designing suitable methods of evaluation and feedback.

1.3.1.The research students were among those who responded to an initial letter in the spring of 2008. All those from the Part III year found out about the project through informal chatter, and volunteered. There was no formal application or assessment procedure. There was a formal presentation of the project in January 2009, and students were asked to express their commitment by purchasing flight tickets, on the basis that the fares would be covered provided that the student actually took part. There was only one instance of a student dropping out of the programme after tickets had been bought, for personal reasons.

1.3.2.The Part III students had sufficient experience to be as effective at teaching as their older colleagues. Absolute confidence with the subject to be taught is important. Beyond that, a commitment to teaching and a desire to engage with their students seems to be as important as further research experience.

1.3.3. Lori Colliander's assistance both in logistical and assessment matters has been mission critical. Even with the experience of one successful

summer school to our credit, I would not be entirely happy to run a future course without such support.

1.4.**Preparation.** From my experiences teaching at Linyi on previous visits, I had come to appreciate the difficulties of language and mathematical background meant that a formal lecturing style would be less likely to engage the attention of the students than more interactive teaching methods. While Linyi students are all familiar with formal lectures (this is the standard teaching format there as well as here in Cambridge), the difficulty in trying to listen to mathematics in a foreign language, coupled with the inevitable discrepancies between assumed and actual mathematical background would mean that most if not all the Chinese students would find it very difficult to learn in this format. Our hope was that by involving students from the start in working illustrative examples together, the difficulties of language and could be overcome. To prepare for our teaching, we then had to learn methods of teaching in this way, and then get some practice at using them.

1.4.1.**Toni Beardon's lesson.** We are lucky in having Toni Beardon associated with the CMS. With her years of experience teaching in schools, teaching teachers, and also teaching at the African Institute of Mathematics where students face similar challenges, she was ideally placed to advise us on how to plan lessons to maximise student involvement, and at the same time provide real-time feedback on the effectiveness of our teaching. She gave us an evening's introduction to teaching methods, at which all our participants were present.

1.4.2. **Practice teaching sessions.** Teaching in this style is not something we had much experience of, so it was necessary to get some practice. We ran three days of teaching practice June 10 - 12, during which all of our teachers had the chance to try out their first few lectures twice in front of IA and IB students. Each of our teachers also listened to their colleagues, and feedback was collected, both from the IA and IB students and from the listening teachers. These practice sessions were interesting for a number of unanticipated consequences.

Part IA, IB students and Summer School teachers during the practice teaching sessions.

1.4.2.1.**Feedback**. By stressing distinction between feedback and evaluation, the feedback we did get was extremely helpful. It might prove useful to redesign the end of term feedback forms presently in use to separate these two distinct (and sometimes incompatible) functions of the forms.

1.4.2.2.**Enthusiasm of the Part IA and Part IB students**. While not all courses had large numbers of Part IA/IB students signed up to listen, that 45 students did show up for half a day (or even up to two days) of additional mathematics immediately following their exams was impressive. Even if we were not intending to return to Linyi, I would be inclined to offer this both for the sake of giving our research

students an alternative experience of teaching, and to encourage the inquisitive spirit shown by our undergraduates.

1.5.**Travel arrangements**. The main group of eleven students travelled together on an Air China flight to Beijing, followed by the overnight sleeper train from Beijing to Linyi. This arrangement worked well, the overnight hard sleeper being a China experience that should not be missed. Following the summer school all made independent arrangements for their return journeys.

1.6.**Living arrangements in Linyi**. We stayed in a hotel that is owned by the university, and is situated at the corner of the North Campus, a ten minute ride from the New Campus, where teaching took place. The preferred arrangement would have been to house us in the Foreign Student's Block, but there were not enough spare rooms to accommodate all of us. It was felt to be (and was!) important that the group stayed together as a group. The Foreign Students Block would have offered some useful amenities (larger rooms, the ability to wash clothes and basic kitchen facilities), but the hotel was convenient and air conditioned. The heat and the mosquitos were both a challenge, and the air conditioning helped with both of these problems. Two of our number shared a room, enabling one room to be used as a common room, with one laptop providing internet access for those who did not bring laptops. It functioned well as a common room, with discussion going on often until late in the night. For meals, the default was a restaurant also associated with the university, although many opted to buy provisions from the supermarket across the road rather than join in the rather unusual breakfasts offered at the restaurant.

1.6.1. The importance of the common room. One feature of the project that greatly enhanced its value as a transferable skills training project was that our students lived and worked in close proximity. There was a continuous undercurrent of discussion about teaching methods, and successful methods were quickly disseminated through the group.

1.7.**Daily schedule, language and culture week**. The first full week was dedicated to intensive language and cultural studies. Breakfast opened in the restaurant at 8:00, and language classes ran from 8:30 - 11:30 and 2:00 - 4:30. The group divided into two classes, one for those with some background Chinese (James Griffin and Lloyd West), and one at the level of complete beginners. It is debatable how much useful Chinese can be picked up in a single week of lessons, however intense. Certainly some students did appear to be able to make some efforts in using Chinese on the strength of just the one week. In the future, I would advise students planning to take part to take at least half a year of Chinese, and to take it seriously. Having some ability in the language has a positive effect on the relationship with the Chinese students. Perhaps Chines languages classes might be run at the Centre for Mathematical Sciences, as happens within the engineering department.

1.7.1.**Meeting with course translators**. At the end of the first week our students met with the teacher from Linyi who would serve as translator and facilitator for their class to review the syllabus. This was the first mathematical exchange of the visit, and was a challenging moment. Not all the translators were familiar with their subjects, and not all of them knew the technical language. Some were outstanding, and provided exactly the support needed. In many cases the courses were significantly revised on the strength of these discussions.

Meeting with our translators

1.7.1.1.Next time, this meeting should take place earlier, and our students should have time to go through the whole course with their teacher/translators.

1.7.1.2.This should provide us with our best contact with teachers in the maths department at Linyi. We missed a trick by not creating occasions which would enable our students and these teachers to interact. One suggestion (Martin Gould) was that we might invite those teachers to give short presentations to us, so that we get a chance to learn where their interests lie. Certainly some such occasion would be helpful, as would having a longer period for our students to work alongside their teacher/translator to revise the course content.

1.7.2.**Visit to Meng Shan**. This gave us our first exposure to rural Shandong, as well as a very pleasant day together, with our language teachers and our hosts.

1.8.**Daily schedule, teaching week**. The pattern of these days was that we left the hotel after breakfast by bus to arrive at our classrooms by 8:30. The basic teaching schedule was as in the schedule. Each “A” course was paired (as far as possible} with a related “B” course, and the respective teachers would listen in on each other’s courses. During the study sessions, new material would not be introduced (or that was the plan, at least) and students would have the opportunity to ask for help with homework or clarification of what had been said in class. The study sessions for the A courses were held after the B

Daily Schedule:	
8:30 - 9:20	“A” courses
9:20 - 9:30	break
9:30 - 10:20	“A” courses
10:20 - 10:40	break
10:40 - 11:30	“B” courses study session
11:30 - 3:00	lunch, rest
3:00 - 3:50	“B” courses study session
3:50 - 4:00	break
4:00 - 4:50	“B” courses
5:10 - 6:00	“A” course study session

course lectures and vice versa, in order to give students time to attempt the homework on their own and with their colleagues before asking their teachers

Course Pairings			
A Courses		B Courses	
Course	Teacher	Course	Teacher
Group Representations	James Griffin	Elliptic Curves	James Cooper
Galois theory	Lloyd West	Number Fields	Barinder Banwait
Riemann Surfaces	Patrick Orson	Knot Theory	Dean Bodenham
Functional Analysis	Dale Winter	General Relativity	Peng Zhao
Ramsey Theory	Ta Sheng Tan	Percolation	Matthew Tointon
Linear Regression	Qing Wang	Bayesian Statistics	Hui Guo
Queueing Theory	Martin Gould		

1.8.1.1. The system of pairing teachers was in some cases very useful and in some cases not the most useful way in which time could have been spent. Once teachers had engaged with their classes, many regretted that more time was not available for socialising with their students. Initially, it was probably a good idea, offering moral support and in some cases translation assistance.

1.8.1.2. Classes often over ran. The teachers were keen to achieve at least some of their stated objectives, and their enthusiasm appeared to be matched by that of their students.

1.8.1.3. After the first day, when packed lunches were brought in to the common room, we joined the students at the cafeteria or the free enterprise market behind the New Campus for lunch. The common room was by common consent silent during the rest time that followed.

1.8.1.4. The common room set aside for our use during the summer school worked brilliantly. It offered tables to work at, internet

Nap time in the common room

connections, comfortable chairs to sleep on, and a well stocked fridge. All facilities were well used.

1.8.2.Dance evening. On the evening of the 10th, Qing Wang led an evening of Scottish Dancing. This was a terrific success, and served the all important function of mixing our students with their students on an entirely non-academic basis. Such activities should be regarded as an essential component of repeat projects, and should be held at an early point in the project.

1.8.3.How to prepare a talk. On the 11th, in order to assist the Chinese students preparing their presentations on the 14th, I gave a talk on how to prepare a seminar talk. Certainly the presentations on the 14th were uniformly prepared to a very high standard; whether due to this session or through the students' own prior experience, I couldn't say.

1.8.4. Preparation day. On the 13th July there were no formal teaching sessions. Most of the Cambridge contingent took advantage of a morning off to visit some historical sites in downtown Linyi. In the afternoon some people went shopping and visited the wholesale market. Others made themselves available to their students for part or all of the day.

1.8.5.**Presentation day**. The schedule for this day was essentially the same as the daily schedule, with the following changes. Each class had chosen a number of students to present short talks reviewing material from or related to the course. A course students listened to B course presentations (as well as their own) and vice versa. The talks were all in English, and the standard of presentation was very high. The morning study session was replaced by a student feedback session, and the afternoon study session was replaced by a closing ceremony.

1.8.6. **Evaluation day.** The final morning was given over to three feedback sessions, which will be described in section 3. After lunch the group began dispersing to its various destinations.

2.Financing the project. Having failed to secure funding from the British Council's PMI2 student mobility scheme, and with the International Office ultimately unable to contribute, the financial plan was that students would seek travel grants from their colleges and other sources to cover their international travel. The Department of Pure Mathematics and Mathematical Statistics offered to underwrite the shortfall out of transferable training funds, thus freeing me from personal financial responsibility for the project. Moreover, it very generously contributed secretarial support before and during the project, as well as funding Lori Colliander's travel expenses. Linyi Normal University took responsibility for travel between Beijing and Linyi as well as all food and lodging during our stay in Linyi. This support was generous in every detail, including transport between the hotel and the

New Campus, and the well-stocked fridge in the Common Room in the mathematics department. We were superbly well looked after.

2.1.Breakdown of contributions from UK sources. The total cost of airfares was £6569.84. Students managed to raise a total of £2900 from College sources: nine students secured travel grants and bursaries ranging from £200 to £500. The shortfall has been covered by the Transferable Skills Training funds and other funds within the Department of Pure Mathematics and Mathematical Statistics at Cambridge.

2.2. While I regret that the financial burden on the department was more than it might have been had we been successful in our bid for PMI2 travel grants, the stipulation that the visit must exceed a month's duration might have made it difficult for research students to take part. Mathematical conferences take place during the summer, and few research students can afford the time for extensive travel. This would not have affected our Part III graduates, who generally have a summer free from responsibilities which can be well spent abroad.

2.3.I am not able to express adequately my gratitude to the department and to the School of Physical Sciences for their support of the project. As a transferable skills training it was outstanding, even outstanding value. As a teaching exercise it developed an aspect of teaching which is not available within the normal university experience. Since all participants contributed to the planning and running of the project, they will be in a good position to take part in and even lead similar projects. Western participants will have a much greater respect and understanding for the challenges faced by Chinese students coming to study in this country. It was a very effective academic, cultural and linguistic interaction.

3.**Feedback**. Feedback must happen at two levels. Certainly there must be formal channels for feedback. But equally, a well-designed project should provide opportunities for ongoing feedback as a matter of routine. For this, it is usually sufficient to provide occasions and space when the team is together. Meal times, the bus rides to and from the New Campus, the common room at the hotel and the common room at the mathematics departments created such opportunities, and these opportunities were well used. (By contrast, had we stayed with local families, which might have provided interesting cultural experiences, we would have lost valuable opportunities to share teaching experiences.) In addition there were formal feedback structures.

3.1.Chinese student feedback. Lori Colliander produced a course questionnaire, and we went over the questionnaires with the student leader (group leader) of each group The intention was that on the 14th each group leader would spend an hour discussing the questions with the others in their class, and collect the responses. On the 15th, we invited the group leaders to meet with myself and Lori to present the responses of their group. The questions and a summary of responses are presented in Appendix A.

3.2.**Cambridge student feedback**. The minutes of the formal Cambridge feedback session is presented in Appendix B.

3.3.**Review meeting with the Mathematics Department at Linyi**. The final meeting on the morning of the 15th brought those representing the mathematics department at Linyi (Prof. Gong and Prof Jin, Dr. Diao Ke Feng and Dr. Fu Zun Wei) together with myself, Lori Colliander, Martin Gould and Peng Zhao, who will have responsibilities for organising next year's summer school. We reviewed our findings from the previous two feedback meetings, as well as hearing of the mathematics department's own feedback meeting with their chosen student representatives.

4.**Looking forward**. We are in the happy position that the 2009 Linyi Cambridge Mathematics Summer School surpassed all expectations. We intend to repeat the project next summer, and are considering ways of extending the programme.

4.1.**Visit to the British Council**. On the 15th July, Liya Yu, Dale Winter and I visited the British Council Offices in Beijing, where we were met by Tina Ren and her colleague. We had a generous opportunity not only to present the 2009 Summer School, but also to discuss funding of next year's Summer School and discuss ways in which the project could be developed and extended.

4.1.1.**Extension to include students from other UK universities as teachers**. This will happen. The student organiser for next summer's project will be starting PhD studies at Oxford next year. I would like to invite students from Warwick next year as well.

4.1.2.**Extension to include other subjects.** Liya Yu, who read philosophy at Cambridge (BA 2008) gave a series of lectures on political philosophy at Linyi over a period of five days that coincided with the language and cultural study part of the main visit. The design of this visit differed in many respects from the design of the summer school. These lectures were given to a large audience and were not part of a larger summer activity. They were formal lectures, although Liya did offer some chance for smaller group discussion. There was an exam at the end of the lectures. Nonetheless, this successful experience establishes the precedent that even in courses which are far more dependent on language skills, a summer school modeled on the one we have just run would certainly be possible.

4.1.3.**Extension to other Chinese universities**. Clearly this model could be used to run summer schools at other Chinese universities. However, the success of this project depended very critically on superb support from Dr. Xu and the top administration at Linyi, and personal active involvement in this project certainly commands my loyalty. If the programme were to be developed at other universities, I believe the following elements to be essential in running such a programme.

4.1.3.1.At the Chinese institution, absolute support at the highest level.

4.1.3.2.At the Chinese institution, someone at the departmental level willing and able to make detailed arrangements and correspond with a leader at a UK university.

4.1.3.3. A leader, most likely a faculty member or post-doc at a UK university with a keen interest in teaching as well as a strong academic interest, who enjoys working with research students and is willing and able to attend to details and correspond with his or her Chinese counterpart.

4.1.3.4. In the event of parallel projects being run at a variety of Chinese institutions, the training of research students taking part in the programme could be done jointly.

4.2. **Extension linking UK universities, established Chinese universities, and developing universities**. Since our return we have discussed the possibility of running a project involving two Chinese universities, one an established university with an active research environment and the other, like Linyi, developing its research potential. The first part of the visit might be a week of seminars by the visiting UK students and their Chinese counterparts at the established university. During that time, UK students might work with their Chinese counterparts to develop

their course curriculum for the second part of the visit, when the UK students together with their Chinese counterparts would run a summer school at the developing university.

4.3. **Financing future summer schools**. We are planning to apply to the British Council for PMI2 student mobility funds again. For students who are research students in Cambridge, the experience is excellent Transferable Skills Training, and appropriate contributions from the TST budget can be requested. For those who are not research students, in the event that we fail to get PMI2 or other funding, participation will have to be on a self-funding basis.

Appendix A. Meeting with group leaders, 15/7/09.

We prepared and distributed a questionnaire inviting the Chinese students to suggest ways in which the programme might be improved or needed to be improved.

1.**What attracted students to the summer school**? The responses to this question ranged from simply liking mathematics, the chance to meet Cambridge students, and the chance to practice their English. They were also interested in learning what some of the current topics in mathematics are. The small class size and the interactive style of teaching were also attractions.

2.**What was best about the summer school**? The more relaxed style of teaching was very much appreciated They enjoyed the teamwork (and were exceptionally good at it.) Curiously, the absence of exams was cited as a plus. I had been concerned that without the formal reward and spirit of competition provided by exams students might feel less motivated to work at the ideas. I am delighted that learning mathematics at Linyi works well as a collaborative rather than competitive enterprise.

1. **How is the summer school different from your ordinary classes**.

1.1."STOP!" *It is difficult for students accustomed to large lecture courses to acquire the habit of interrupting a teacher with questions, but in small group teaching it is possible and helpful. Some of the students gained sufficient confidence to interrupt lectures, and more of them at least appreciated the possibility of doing so.*

1.2. Encouraged us to put forward own ideas, whether right or wrong. *For the purpose of teaching, wrong answers are often even more useful than right answers. I am impressed that some of the students began to realise that it really didn't matter if their first guess was not a correct one, and also very pleased.*

1.3.How to solve the problem, not the result. *In secondary school, the priority in mathematics is on getting the right answer. In truth the right answer, even at that stage, is valuable mostly as evidence of understanding. Approaching the stage of doing creative mathematics, the priority is to understand the method of solving the problem and why it works, rather than the answer. Again, it is gratifying to see that the students had begun to shift their priorities.*

1.4.The classes were small and active. *In a small class it is possible to involve students in a more active way. This seems to have been appreciated.*

1.5.Teacher, small class teaching, atmosphere made students feel relaxed.

1.6.Starting from simple things they already knew helped with confidence.

1.7.Teachers would ask a question, and then invite students to discuss in small groups. This resulted in a deeper understanding than when students are just told the answer.

1.8.There was sufficient time to think about the theory on their own.

3.**How might the summer school be improved**? There were many suggestions, some of which we will be able to incorporate in future running of the programme. *Our responses are in italics*.

3.1.The time was too short. *We intend running the classes for two weeks on the next occasion.*

3.2.Students should be allowed to choose the subject rather than being assigned to subjects.

3.3.More time spent with teachers outside the class would be appreciated. *The dance evening was very popular. In future programmes, our teachers need not sit in their colleagues' class after the first day or so. They would then be free to spend time with their students.*

3.4.The teachers need to be better informed on what students know and what they don't. *Teachers will choose subjects to follow on from the Linyi syllabuses in future programmes.*

3.5.Make sure the translators know the mathematics before the class starts.

3.6.Maybe start at the end of the summer holiday would be better, as Linyi students were tired from their exams, and many also had to start preparing for their graduate school entrance exams. *Late August, early September has been suggested for the next running of the project.*

Free time spent with students increases teaching effectiveness

4.**How did the summer school help further your mathematical studies**? Here too there were lots of responses.

4.1.It demonstrated how mathematics could be taught by examples. *Clearly, the pressure of time in formal lecture courses precludes the possibility of placing such emphasis on examples. We set out deliberately to use examples both as motivation and in lieu of formal proofs to minimise the language difficulty. This principle seems to have had benefits beyond those which we initially imagined.*

4.2.Confidence. The use of examples to illustrate concepts and results gave students confidence in their understanding of the results.

4.3. Teamwork. Helping students to see their peers as collaborators rather than competitors is a challenge in every mathematics department. The students here seemed to enjoy making that transition.

4.4.Focus on problem solving. Particularly in the more abstract courses, there is a tendency to concentrate on constructions and theorems. The deliberate focus on examples and problems even in the pure courses helped to put the theory into perspective: even in the pure courses, the theory is a tool for solving problems.

4.5.Broaden horizons. Given the natural bias towards applied subjects in a developing university, the variety of courses offered introduced the students to a wider view of mathematics.

4.6.The value of discussion. - "This makes me know other people's ideas - so I have two ideas". Learning to discuss is difficult in all universities. I was very impressed at the degree to which the Chinese students were able to learn from their colleagues in this way.

4.7.Getting answers wrong on the board does not result in losing face. The policy of getting students up to the blackboard, encouraging them to write their guess at a solution, and then encouraging the class to help them did work in at least some of the classes was deliberate. Those students who had this experience gained very useful skills well beyond mathematics.

4.8.The habit of asking question of anyone, whether they are more or less experienced. There is a saying of Confucius, where three people walk together, one is teacher. Thus some of the students have rediscovered old truths.

5.**How might these methods be continued**?.

5.1.Small discussion based classes with the teachers could be introduced to supplement formal lectures in advanced classes..

5.2.Have more teachers experience these teaching methods.

5.3."You have to change things from the top". This was an interesting comment from one of the students. The possibility that we would listen to the comments, pass on suggestions, and in this way students would have the potential to influence teaching practice within the university was a concept that seemed to be new and exciting to them.

6.**Miscellaneous comments**.

6.1.The chance to discuss mathematics was very much appreciated.

6.2. Would there be any possibility of going abroad, perhaps visiting Cambridge?

6.3.The dancing really helped!

Appendix B. Meeting with Cambridge teachers, 15/7/09.

Following the session in which the group leaders reported their discussions with their groups, the Cambridge students discussed the design and running of the project. The topics raised and discussed were as follows.

1.**Should the course be longer**? The quick answer to this question was yes. Most students felt that two five-day weeks of classes separated by a weekend of relaxation would be better. It takes a while to make contact with the classes; it would be good to have longer to profit from this initial effort. No more course material would be necessary. All our students felt that they had prepared too much material. A longer course would also allow a more leisurely pace to the stay.

2.**Prerequisites**. Modifying the course to accommodate the Chinese students' background takes a lot of time and is very tiring. It would help to get this right while planning the courses. Rather than sending the proposed curricula to Linyi for their approval, we might manage better by asking Linyi to provide us with the details of the syllabus that the students have studied. The table of contents of the course textbooks would provide this information.

3.**The function of the translator/assistant teachers**. Each of our students had a teacher from Linyi to assist them with translation, and help to ensure that the Chinese students understood what was being said. In some instances this worked brilliantly. In others this assistance was not effective. Sometimes this was because the assistant assigned to the course had no familiarity with the area. In some cases the translator was not familiar with the English terms. Lexicons supplied beforehand would help. It would help to meet with these translators early enough to go through the entire course with them, to further everyone's confidence. It is important that a translator should be assigned to a course which at least shares a common background. It is not important that the translator knows

the subject matter already; listening to such courses is a good way for a mathematician to broaden his or her interests.

4.**Should the format of the course be different, allowing for the students to do more talking?** Given the high standard of presentations given at the end of this summer school, we discussed the possibility of getting the Chinese students to do more of the talking during the course of the summer school, not just at the end. A method we will be trying out this year with Part III students to supplement their lectures may also work in the summer school setting. The plan would be to supplement lectures by a review of the lesson presented by a student, and worked problems presented by other students. This supplementary session would be separated from the lesson by sufficient time for those presenting reviews or worked problems to have a chance to ask the course teacher for assistance if required. The plan would have the added bonus that the Chinese students are vastly better at understanding each other speaking English than they are at understanding westerners speaking English.

5.**Teaching methods**. We learned a lot about small class teaching, and these ideas should be passed on for the use of later summer schools.

5.1. 1.2.4 many method. Toni Beardon introduced this idea to us. When asking students to think about a problem in class, first give the students a few minutes to think about the question on their own, then ask them to confer with their neighbour, and finally as pairs to get together and compare their methods. Finally, invite one student to present the method their pair or foursome used to the class. If the method is not complete, then invite other students to suggest modifications.

5.2. Sit amongst the students. While students (or pairs, or foursomes of students) are working together as above, walk among them. Sit down among them if help is desired: students who are shy about asking a teacher at the front of a class may be far less shy to ask a teacher sitting beside them.

Matthew amongst his students

5.3. Ask the student to explain. Students seemed to understand each other's English better than our English.

5.4. Ask students to guess - explaining that a right answer is as good as a wrong answer.

5.5.Explain to one student, then ask that student to explain to the class.

6. If the schedule permits, it would be good if advanced students could attend more than one class. More able students contribute as much to class teaching in this setting as teachers do.

7.**Interaction with the department**. Meeting with our translators/assistant teachers gave us one contact with members of the Linyi department of mathematics. We would like to increase the opportunities for contact on future occasions. Several suggestions were made.

7.1.Some more advanced courses/seminars could be offered for those on the staff.

7.2.Our students could present talks on their research interests.

7.3.Perhaps the Linyi faculty could give talks on their research interests to our students.

7.4.Social activities involving our students and Linyi faculty would also enrich our experience.

8. **Logistical support**. We were very fortunate this year in having four native Chinese speakers from Cambridge who were able to provide accurate and easy translation. We were also very lucky to have Lori Colliander able to help us in the preparatory phase as well as travelling with us. I would find the prospect of handling all the administrative detail for such a course daunting. The suggestion was made that perhaps a Chinese student in Cambridge (not studying mathematics) might be willing to volunteer his or her time as support in this way for the sake of the experience and the airfare to and from China.

9.**Language training**. A week, however intense, does not suffice. Perhaps next year a Chinese language teacher might be prepared to give basic Chinese lessons at CMS, as happens presently at the Engineering Department.

Appendix C. Meeting with Linyi Staff, 15/7/09.

Four points were raised by staff from the Linyi Mathematics Department.
1. Advice on the course schedules for use throughout their academic year would be appreciated.
2. If, before next year's summer school, detailed pre-requisites could be sent at an early stage, prerequisites could in some cases be included in the course schedules. In addition if UK students have access to the course schedules at Linyi, topics could be chosen more carefully to complement what is covered during the academic year.
3. The staff at Linyi would like greater interactions between our teachers and their teachers.
4. They would also like their students to have a bigger flavour of where their experiences of mathematics fit into the bigger picture (even of science as a whole).

Suggestions raised in the Meeting:

1. Timing of the summer school. - Move the teaching to either the end of June or end of August.
2. Course Design - More care needs to be taken in tailoring the courses to follow on from the Linyi teaching schedules.
3. Funding - For the coming year as for the 2009 school, the plan is for the UK students to find funds for the international travel, while Linyi would continue to take responsibility for travel between Beijing and Linyi, accommodation in Linyi (both for the UK teachers and for students attending the summer school). The department in Linyi are looking for funding from the Chinese government. We will apply again for British Council funding.
4. Visit - Fu Zun Wei and Shen Liang (or perhaps even 6 people altogether, depending on funding) have been invited to Beyond Part III in March 2010. This will also provide an excellent opportunity to plan the details of the 2010 face to face.
5. Making a Chinese-English AND English-Chinese Mathematics Dictionary would be a useful way for both Chinese and English participants to overcome some of the language difficulties as they occur.
6. We might seek to recruit UK students whose mathematical interest complemented and extended interests already represented at Linyi.
7. It would be a useful cultural experience for us to listen to talks by Linyi staff about their interests. More contact doing social things with the teachers would also be beneficial.
8. The role of the translators needs to be clarified. They didn't always have the required background, which made it very difficult for them to provide the support needed. If those coming to give courses have interests already represented at Linyi this will be less of a problem.

9. Could we run a course in the summer school JUST for the teachers? Perhaps even 2 - one pure(ish) and one applied(ish)? This could include research students as Linyi begins to develop a PhD programme
10. The Ceildh was very well received by the students. Putting a high priority on such social activities brings substantial rewards.
11. This must be a two-way exchange. Although we do have a lot of information to share with Linyi, we REALLY need to understand that they also have a lot of things to teach us!
12. The format of the presentations given by the students needs to be revised. While the standard of talks was high, those listening were not so well motivated to pay attention.
13. Students need to be allowed to choose the courses which they LIKE! Ideally, students might be able to read the course syllabuses on the web, discuss which would be suitable with their teachers, and then sign up, perhaps indicating a first and a second choice.

Appendix D. Outputs and outcomes.

1. Outputs.

    1.1. 13 Research and Post Part III students received intensive teacher training, language training, and cultural experience. The teaching experience will initiate a life-long attention to the effectiveness of their teaching practice. The cultural experience will equip them to handle the issues experienced by their Asian students with increased sensitivity.

    1.2. Approximately 200 Chinese undergraduates had the experience of small class teaching methods and the chance to gain insight into topics of current mathematical interest. Of these, approximately 60 will be continuing at Linyi, and will be able to assist in developing the use of small class discussion based teaching within the mathematics department at Linyi. Many others will be continuing in mathematics at other universities, and will bring both their knowledge and their experience of small class teaching to the departments where they will continue their studies.

2. Outcomes.

    2.1. Linyi Mathematics department is currently discussing ways in which their present teaching practice might be supplemented by such small class discussion based opportunities.

    2.2. Cambridge University departments of mathematics will be adapting some of the ideas developed in the course of the summer school to support the Part III teaching.

    2.3. Up to six members of the Mathematics Department at Linyi may attend the second Young Researchers in Mathematics conference in March 2010, extending the exchange between departments.

Marj Batchelor
Graduate Training Officer
Department of Pure Mathematics and Mathematical Statistics,
Centre for Mathematical Sciences
Wilberforce Road
Cambridge, CB3 0WB England

Telephone: +44 (0)1223 765896
Fax: +44 (0)1223 337920
E-mail: mb139@cam.ac.uk