
AC 2011-584: COMPACT INTERNATIONAL EXPERIENCES: ONE PATH TO EXPANDING STUDENT INTERNATIONAL AWARENESS THROUGH SHORT-TERM STUDY-ABROAD ELECTIVE ENGINEERING COURSES

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Compact International Experiences: One Path to Expanding Student International Awareness through Short-Term Study-Abroad Elective Engineering Courses

Abstract

As part of a drive by the home institution for internationalization of the curriculum as well as strong student desire for engineering international studies, compact international experience (CIE) courses were developed. The efficacy of delivering such engineering electives as study-abroad, short-term courses is described through the experiences gained by considering two distinct three-semester-unit courses in a three-week time frame in France and Australia, respectively. While each of these courses, Topics in Fluid Mechanics and Advanced Electronic Circuit Design, focused on its technical content, the desire for student understanding of the cultural environment and the impact of engineering solutions from a global and societal viewpoint were strong driving factors for each. The development of the two courses was undertaken with the hypothesis that CIE courses can successfully be taught in an intersession format while providing an international experience to the students. Assessment of the program was carried out through typical course evaluations, student surveys, and formalized instructor observations. Course evaluations were generally favorable. Students described the courses as “demanding, interactive and useful”, comparing “favorably to other courses I have taken in both workload and intellectual growth”, and stated “I learned a lot more than I would have in a semester.” Instructors noted the considerable workload, but considered the experiences favorably in both technical and cultural context. Overall, CIE courses have been found to be a valuable approach in the delivery of senior-level technical electives combined with an international experience.

I. Introduction

Over the past decade, the number of students at the University of San Diego (USD) involved in an international experience has surged to the point where more than 75 percent of USD’s undergraduates participate in study-abroad programs. There are a variety of reasons for this increase including a drive by the institution for internationalization of the curriculum and a desire of students to incorporate global competencies in their studies. An international experience can be obtained in many different ways, including year-long or term-based study-abroad programs, summer or intersession study-abroad classes, or courses with an international focus taught at the home institution.

Those Engineering students who study engineering abroad typically participate in year-long or term-based study-abroad programs either by directly enrolling into the host institution or through exchange programs. The long duration arguably provides the best basis for an international experience, but cost and differences in the curricula limit this option for many engineering students. Courses with an international focus taught at the home institution (international experience without a passport) are easily accessible to students, incur no additional cost, and can provide a global cultural and engineering context. However, such courses have been rarely

offered in engineering programs. Summer or intersession study-abroad courses provide a balance between the two approaches and are the focus of this study.

It has been stated that engineering study-abroad programs fall generally into eight broad categories ranging from extended field trips and mentored travel to student exchange and dual-degree programs¹. The broad range of international experiences in place suggests to the authors that what is “best” has not yet been determined and that there is room for additional exploration of course formats. It is with that exploratory mission in mind, that the Compact International Experience (CIE) courses were developed at USD. These CIE courses have taken many aspects of other formats into account and blended them together.

Compact International Experience courses are short-term, faculty-led, study-abroad courses with the goal to combine technical engineering content with an international experience. The two CIE courses described here are upper-division undergraduate engineering courses offered to USD students in mechanical and electrical engineering majors, covering technical material in fluid mechanics and electronics at locations in France and Australia, respectively. The course technical content is delivered through daily lectures within a three-week time period. Additional lectures or presentations cover cultural or global engineering topics. The international experience is rounded off by excursions in the host country to further the cultural or international engineering experience. These courses were designed with the hypothesis that CIE courses can successfully deliver technical content equivalent to courses delivered at the home institution while providing an enriching international experience.

One of the most established engineering study-abroad programs is the Global Engineering Exchange Program (GE3) run by the Institute of International Education². In that program, students enrolling courses at a foreign university for one or two semesters and may also participate in a paid internship. Tuition exchange arrangements are made, classes may be taught in English or the language of the host country. Many universities have similar agreements with foreign universities over a broad spectrum of fields of study including engineering. The authors' home institution is one such university.

Another approach is that taken by Boston University College of Engineering in cooperation with the Technical University of Dresden³. In that program, sophomore engineering students travel to Dresden for a five-and-one-half month period over which they complete 20 semester units of credit. There is very close cooperation between the Boston and Dresden faculties: the Dresden engineering courses are taught in English using the same textbooks and course syllabi as used in Boston and provide equivalent laboratory experiences. Since the courses are considered Boston University courses, the problem of transfer of credit is avoided. Programs in the study of German and cultural experiences accompany the technical courses.

Worcester Polytechnic Institute's Global Perspective Program⁴ is a project-based study-abroad program where students complete an engineering project during a typically two-month period. Typically the project is nine semester-units with an additional 4.5 units of site-specific preparation.

Shorter format programs follow an intensive study format popularized by National University (NU)⁵ and others. NU claims their one month per course format gives the student, among other benefits, “unprecedented focus” in their studies. Other, more traditional, universities offer similar short-format courses on a limited basis: typically between semesters (often called intersession) or during the summer months. Such short sessions provide students with an opportunity for a greater role in planning their total program. Students have the chance to enrich their course of study, reduce the overall time spent in school, and decrease their regular course load by careful selection of such short-term courses. The authors’ home institution, USD, is one university committed to short-term opportunities with a three-week intersession term in January and a variety of terms in the summer months⁶.

USD is also strongly committed to global competence through the internationalization of its on-site curriculum and through study-abroad opportunities. This commitment is so strong that USD is currently ranked second in the nation for undergraduate study-abroad participation⁷. In the past, the USD Department of Engineering has been only a very minor participant in intersession and study-abroad courses. The CIE courses are a new venture joining the advantages of each: short-term (three-week) engineering courses taught by USD faculty abroad. The courses described here are the first two intersession CIE courses at USD: one summer CIE course has taken place and another is on the schedule for summer 2011.

The technical content and the international experience are assessed using a four-pronged approach. (1) Student evaluations as required by the home institution provide an overview of student attitudes about the course. (2) Instructor observations and course grades are used to assess the efficacy of the delivery of technical material. These observations are compared to similar courses taught in a semester-long format at the home institution. (3) Students write weekly reflection papers concerning their total experiences. Finally, (4) a survey instrument is used to assess the international experience of the students.

In the following, each of the two engineering courses is described. Next, the assessment methods are described and assessment results are presented and discussed. Finally, conclusions are drawn from the assessment results.

II. Description of these two Compact International Experience Courses

Two engineering courses at the University of San Diego were recently offered as Compact International Experience (CIE) courses: Topics in Fluid Mechanics (MENG 494) was offered to mechanical engineering majors as a senior elective in January 2010 in France, and Advanced Electronic Circuit Design (ELEC 494) was offered to electrical engineering majors, also as a senior elective, during January 2011 in Australia. The two courses are described in some detail in the following.

A. Topics in Fluid Mechanics (MENG 494)

The mechanical engineering senior-elective course Topics in Fluid Mechanics (MENG 494) was offered in Marseille, France during January 4 to 22, 2010. The course further developed selected topics in fluid mechanics, including boundary layers, pipe flow, and an introduction to flow stability and turbulence. It also included an introduction to numerical analysis and the students

simulated flow problems using Comsol Multiphysics on laptop computers.

The course was held in Marseille in the south of France. The students stayed in a university residence with individual bedrooms and bathrooms, as well as shared kitchens and living rooms. The instructor stayed with the students in the same residence. The lectures were typically held at the University of Provence campus outside of the city, but within easy reach by public transportation.

The course met for three weeks with an average of three lecture hours per day. The lectures were conducted in a seminar room at the university. There was one three-hour midterm focused on theoretical material at the end of the second week and a final computational project presented by the students on the last day of classes. The grading was based equally on homework, the midterm, and the final project. The final project was assigned in the form of a research project and results were presented at Creative Collaborations: an annual presentation at the University of San Diego of undergraduate research work.

Cultural activities included visiting a variety of local attractions (Chateaux d'If, Vieux Port, Vieille Charite, Calanques), a weekend trip to Aix-en-Provence, and an overnight weekend trip to Paris. The students also used afternoons and evenings for a further exploration of the city and its surroundings. French language and history lessons to facilitate greater cultural immersion for the USD students were conducted by faculty, researchers, and students of the University of Provence on an almost daily basis.

B. Advanced Electronic Circuit Design (ELEC 494)

The electrical engineering senior elective course, Advanced Electronic Circuit Design (ELEC 494), was offered during January 1 to 18, 2011 in three Australian cities: Sydney, Newcastle, and Canberra; with an optional three-day sightseeing excursion to the Great Barrier Reef at the end of the course. The course explored contemporary electronic design beyond that usually taught in the two electrical engineering core electronics courses and focused on the analysis and design of analog and digital electronic circuits and systems including: oscillators, non-linear waveform generation and waveshaping, power electronics, communication circuits, and digital gates. There was a strong emphasis on computer-aided analysis and design.

The textbook used was an out-of-print electronics textbook coauthored by the course instructor. Since the authors now own the copyright to the textbook and it is undergoing revision for a new edition, electronic copies were made available at no cost to the students for their private use. While a few students own hard copies of the textbook, everyone, including the instructor, used the electronic copy exclusively. Each student was provided with a licensed copy of National Instruments Multisim™ 11.0 for use as a circuit simulator – arrangements were made so that the department's license could be extended to the student laptops for this course. The student laptops were evenly divided between PCs and Macs.

In order to facilitate general computational needs and tradeoff studies each student was expected to have a math computational program installed on their laptop. The instructor prefers Mathcad

for this purpose and the majority of students used it as well. Three students chose MatLAB as their math primary computational program.

The course met for eighteen days with thirty-five scheduled classroom hours and an additional two-hour final exam period. The lectures were typically conducted in a classroom, or conference room at one of the varied locations. The students stayed in a college residence across the bay from Sydney for the first week and youth hostels thereafter, typically in rooms of two to four students. The instructor stayed with the students in the same residences in a private room and held office hours in that room or in a public room at the hostel. Public transportation and private coaches provided easy access to the varied locations.

Since the course instructor had not previously traveled to Australia, an educational support provider, AustraLearn, was engaged to make arrangements for housing, transportation, tours and excursions, as well as a vast variety of details that make such an adventure work. Both technical and cultural activities were planned by AustraLearn and provided a full plate. Tours and excursions included locations that were intended to be purely cultural (Sydney Tower, Blue Mountains Eco Tour, etc.), to be purely technical (Canberra Deep Space Communication Complex, Sydney Observatory, etc.), and some that were to be a mix (Sydney Opera House technical tour, Canberra Sustainability House, etc.). This assortment was intentional and, as such, emphasized that this international experience was more than just a USD engineering course taught in another country. In addition, the students toured three Australian universities (University of Technology, Sydney; University of Newcastle; and the Australian National University) where they were introduced to the research activities at the universities and explored opportunities for further international study.

III. Assessment and Results

In the following, both the technical content and international experience are assessed. First, results from teaching evaluations as required by the university are presented and compared to those from a comparable course. Then, student performance is discussed in terms of grades and faculty impressions and again compared to a previous course. The students' international experience is assessed using a survey instrument. Finally, student impressions of the international experience from reflection papers are described.

A. Assessment of course delivery by teaching evaluations

The course Topics in Fluid Mechanics (MENG 494) was previously offered by the same instructor as a senior technical elective in a semester-long format in spring 2007. The course met for three lectures a week throughout the semester (41 lectures). There were 8 mechanical engineering senior students enrolled in the class. The topics covered in the course were identical to the CIE course, but the Fluent CFD software package was used instead of Comsol. There were weekly homework assignments based on technical material from fluid mechanics or numerical analysis as well as computational modules using Fluent. Due to the semester-long format, the homework volume and the number of computational projects were higher compared to the CIE course.

The courses were evaluated differently by the students. For the semester-long course,

Instructional Assessment System teaching evaluations with a 6-point scale (0-5, 5 being highest) were used. Overall, most students selected the highest (excellent) or second-highest (very good) selection to evaluate the varied aspects of the course and the combined median was 4.2. For the CIE course, teaching evaluations were provided by USD's International Center which used a 3 or 5-point scale. For the 3-point assessment statements, all students selected the highest selection. For the 5-point assessment statements, students selected the highest (outstanding) or second-highest (above average) selections. The combined average of the 5-point questions was 4.4.

While Advanced Electronic Circuit Design was a first-time offering, the instructor has previously presented a senior elective course in Analog IC Design in a semester-long format and was the course instructor for these students when they were enrolled in the prerequisite electronics courses. Those courses were all in the traditional format, with the lecture portion meeting for three 55-minute periods every week (between 37.6 and 38.5 instructional hours). The quantity of coverage in all courses was essentially the same: the two prerequisite courses cover 11 chapters in two semesters while the CIE course covered 5 chapters of the same text in three weeks. Homework in the CIE course was, by necessity, somewhat less. The instructor feels that this reduction in homework was completely compensated for by a vast expansion of student-instructor interaction facilitated by close-proximity living accommodations.

As was the case in the other CIE course, the home-institution and study-abroad courses were evaluated differently by the students. Overall for the home-institution prerequisite courses, most students selected the highest two categories on the 6-point scale (0-5) with a combined average ranging between 4.1 and 4.9. For this CIE course, teaching evaluations were provided by USD's International Center which used the 3 or 5-point scales. For the 3-point assessment statements, all students selected the highest selection. For the 5-point assessment statements, students selected the highest (outstanding) or second-highest (above average) selections. The combined average of the 5-point questions was 4.79

B. Assessment of student performance (grade distributions, etc.)

It appears that the technical evaluation of the two Topics in Fluid Mechanics (MENG 494) courses was quite similar. For the semester-long course taught at the home institution, the grade distribution consisted of 4 As, 3 Bs, and 1 C with an average GPA of 3.4. For the CIE course, 3 As and 1 B were given with an average GPA of 3.7. The GPAs are relatively high in both courses. There are two main reasons for this: first, both courses were senior electives and only students with a strong interest in the topic enrolled in the course. Second, due to the small student numbers in both courses, a high level of student-faculty interaction was present. This argument is particularly applicable to the CIE course with just four students.

In ELEC 494, there were two midterms and a final exam on the last day of classes. As for a typical course at USD, grading was based primarily on homework, the midterms, and the final exam. However an additional component relating to the international experience was factored into the final grade for this CIE course.

Given the close living accommodations for the students and the course instructor, homework submission was done mostly orally. Students showed the instructor their work and computer simulations and the instructor often made suggestions as to how to improve the submission:

students made changes before homework grades were recorded. As a result, all the students achieved homework scores greater than 92%: typical homework grade averages for this course instructor during a normal semester lie in the 75-90% range.

Given that Advanced Electronic Circuit Design was a first time offering, technical comparisons are a bit more difficult. However, since the course instructor also taught these students in the prerequisite courses, direct comparisons can be made. The students enrolled in the course were a select group whose grade average in the prerequisite courses was slightly above a B+ (~3.4) while the total student population averaged a B- (~2.7) in those courses. For the CIE course, the average grade was somewhat higher: A- (~3.6). As was the case for the other CIE course in this study, it appears that strong student interest, close student-faculty interactions, and the concentrated, single-focus format are the primary factors for improved student performance.

C. Assessment of the international experience

After each CIE course was completed, students were asked to complete a survey concerning their international experience. This survey was comprised of 19 queries taken from the USD School of Leadership and Education Sciences international experiences survey, 3 queries comparing the CIE courses to USD courses given in the traditional semester-long format and during the three-week intersession on campus, and 2 queries concerning the international experience as related to engineering. The survey used a 6 point scale ranging from “strongly agree” to “strongly disagree” and asked for short statements relating examples from the student’s own experience related to the queries.

Due to the small total enrollment, the following assessment of student international experience is presented collectively. Students perceived that their international awareness after this experience was high with average scoring over the 19 queries in the “Agree” category (1.96 where 1 is “Strongly Agree”): the distribution of results is shown in Figure 1.

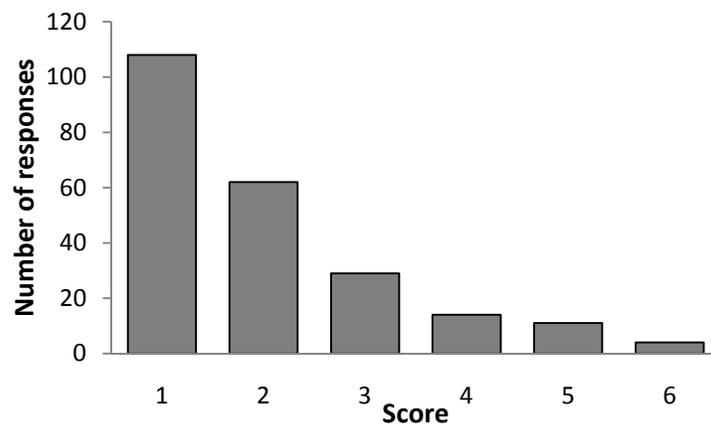


Figure 1. Overall Student Perception of International Awareness

Highest scoring awareness queries were:

- I have thought about the differences between myself and people from other countries (1.17)

- I know the currency conversion rate for the U.S. dollar to a least one foreign country (1.17)
- I have looked up something (location, fact, etc.) about another country (1.25)
- I have looked up the meaning of a non-English word (1.25)
- I have thought about the similarities between myself and people from other countries (1.33)
- I have watched or listened to a non-American TV station, news broadcast, or other media show (1.42)

The CIE courses compared well to more traditional course formats on those three queries:

- The format (content, workload, material learned, etc.) of the study-abroad course compares well to a three-week intersession class at USD (1.38)
- The format (content, workload, material learned, etc.) of the study-abroad course compares well to a semester-long class at USD (2.08)
- There was more faculty-student interaction during the study-abroad course than during a class at USD (1.67)

Comments included:

- “Material learned was relatively comparable, but workload was more because we fit about the same # of assignments and tests in about 1/5 the time.”
- “This [faculty-student interaction] was the best part of the course.”
- “Lots more interaction.”
- “In my experience the workload for Advanced Electronics was more than any 3-wk class.
- compares “favorably to other courses I have taken in both workload and intellectual growth”
- “I learned a lot more than I would have in a semester.”

The relationship of the international experience to engineering also was favorably perceived by the students on the 2 queries relating the aspect of the courses:

- This international experience enhanced aspects of my engineering knowledge (1.75)
- This international experience has helped me understand the impact of engineering solutions in a global and societal context (2.08)

Comments included:

- “the class itself was great and seeing how another country does some things broadened my perspective.”
- “very interesting to see the opportunities and work being done abroad.”

D. Student observations from weekly reflection papers

For Topics in Fluid Mechanics (MENG 494), reflection papers were assigned weekly to capture students’ observations and attitudes on a regular basis. The reflection papers were mandatory, but their content was not graded in order to encourage students to write openly about their impressions. The reflection papers were handed in by e-mail and some students decided to copy friends and family on their writing.

The reflection papers at the end of the first week contained thoughts on the travel preparations, travel to Marseille, and initial impressions. Travel preparations included movies: “My mom made me watch Taken (it’s about 2 girls who get kidnapped in Paris) which made both of us even more paranoid.” Initial impressions often centered on the language barrier: “I really thought that a lot more people here would speak English.” “Trying to function in a society without speaking any language makes me feel like I’m 3 years old again.”

Impressions of the second week showed efforts to talk with locals and the enjoyment of the surroundings: “We ended up eating dinner at a new restaurant and made friends with the table sitting next to us, which was a couple and their friend.” “I absolutely loved going to Notre Dame and the Louvre and seeing the Eiffel Tower at night (even though it was miserable in the rain). I really liked walking around Paris on the second day when it wasn’t raining.”

The final reflection papers from the end of the course often contained insightful comparisons: “The French know a lot about our popular culture, history, and politics while we hardly know anything about France.” “One of the many things I will take away from this trip were the people that we met.”

Overall, the comments in the reflection papers suggest that the students did obtain an international experience during the course: “Overall, I had a fantastic time in France and I miss it already. Even though it was expensive, we couldn’t communicate with anyone, and we ate bread for 3 weeks straight, it was so much fun. I hope to go back one day, hopefully with a little more money, and explore more of France especially Normandy and maybe Paris. I’m very grateful to have this abroad experience that I originally did not think I was going to be able to have.” “It was an experience that will definitely impact what I do in the future. It opened my eyes to traveling and experiencing different cultures.”

In that Advanced Electronic Circuit Design was presented in three different cities, it was decided to assign the reflection papers on a city-by-city basis. At the end of each city stay, students were asked to write “a short (~ one page) reflection paper concerning your stay in that city, the cultural differences that you noted, the engineering-related tours and lectures, and anything else that was of particular interest ...” While the content of the papers was not graded, a sincere student effort was required to achieve full credit (tours, guest lectures, and global impacts accounted for a portion of the course grade). Papers were handed in as soft copies, typically by direct downloading to the instructor’s laptop through the use of flash drives.

The time in Sydney was quite busy with class and at least one tour every day. The reflection papers contained some of the obvious cultural and technical differences: “One of the first things that I realized was the use of 240V electric lines which directly affected me as I needed to buy an adapter. The next noticeable difference was the fact that the car’s steering wheels were on the opposite side of the car.” “One of the biggest, and probably my favorite, cultural differences I’ve noticed so far is that in Australia, the ‘price you see is the price you pay.’ When you sit down at a restaurant, you *aren’t supposed to* tip the waiter/waitress. Even at bars you aren’t supposed to tip the bartender...” “First of these is the public transportation system: INFINITELY better and more reliable than anything I have ever experienced on the West Coast of the States. Taking the ferry every morning from Manly Beach to the city was a great way to start the day. The people

are all very friendly and want you to feel welcomed.“ The visit to the University of Technology, Sydney, while primarily technical, provided insight into some cultural differences: “Another surprising thing about their education was the fact that college is not about moving super far away from where you are from, but instead staying close to where you are from.”

Our educational provider arranged tours in the Sydney area got mixed reviews: “I was a bit disappointed at some of the tours' lack of technicality. Of the three technical tours, none of them got into many technical details, which would have been fascinating.” “My favorite activity, by far, was hiking in the Blue Mountains... After a week of different ‘go green’ tours, the Blue Mountain tour guides reminded us exactly what we were trying to save.” “The nature walk at Blue Mountain was probably the second most technical tour, next to the Powerhouse. One of the guides had previously been an electrical engineer and worked in telecommunications. He told us about lightening strikes and how they destroy so many electronics due to the power of the strikes.”

Time in Newcastle was somewhat less structured, but still busy. Once again traffic conventions were noted: “When a pedestrian started to cross, the cars (and ALL of them did this) would drive up to the cross walk that the pedestrians were in and wait for them to cross, despite the tail end of their cars being in the intersection. Quite different!” Students responded well to the tour of the University of Newcastle and found some engineering highlights in town: “It is a very interesting city to see because there has been a lot of influence from engineers in the city since it is one of the more industrial of towns found in New South Wales.”

Unfortunately the local population in Newcastle didn't necessarily make a good impression on the students: “We got some weird looks from the locals and some of the people were very strange.” “The worst part of my stay in Newcastle was being attacked by a drunk man.” “The whole city had a weird twilight zone feeling to it.” Still there were some brighter opinions: “The people of Newcastle are much more down to earth than in Sydney.”

By the time of the last reflection paper, student commentary diminished somewhat to more of a report of daily activities than true reflections on global perspectives. Nonetheless, a few comments are touched on the subject: “It was nice to see such a level of cooperation between the Australian and United States governments [Canberra Deep Space Communication Complex].” “It [Canberra] was urban enough that I got an urban feel, but was also designed in such a way that I felt the culture and kind of at home.”

Overall the students gained a good perspective on our greater world: “I feel that I am more culturally expanded and have a wider view of what the world is about from my travels in Sydney.” “As a class we have learned a lot about Australian culture as well as electronics.” “The overall intersession class in Australia was a great experience. I'm very glad I decided to take this opportunity.”

IV. Summary and Conclusions

The Compact International Experience course format, as described in this paper proved to be an effective format for the delivery of two senior elective engineering courses: one in France and one in Australia. Despite the short timeframe of delivery, all evidence collected (student course

evaluations, instructor observations and course grades, student weekly reflection papers, and an assessment of the international experience) point to an educational experience equivalent in course content and depth of coverage to that of typical semester long courses delivered at the home institution coupled with an enriching international experience. Extremely strong student-faculty interaction was achieved by close-proximity housing accommodations and was a strong factor in successful course delivery.

That is not to say that everything always goes exactly as planned when delivering a course in a short time abroad. In Australia, there were three student computer failures – one of which was catastrophic. Similarly, one must be extremely explicit about needs and careful when working with an educational support provider as was the case in Australia. Problems encountered included: classrooms without a board to write on, scheduled tours that were advertised to have electrical engineering technical content but turned out to be the same tour as any tourist might take, and some living environments more suited for youthful tourists than students deeply engaged in a technical course. More careful planning and attention to detail could have avoided many of these difficulties.

In summary, the CIE format works well. Course instructors are on call 24/7 throughout the duration of the course and entirely responsible for the students' educational and cultural experiences as well as their general wellbeing. Those responsibilities create a workload that is significant by any measure. Without a doubt, both of the instructors feel that the work needed to successfully deliver a CIE format course is worth the investment of time and effort. Each feels enriched by the experience.

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