Compact International Experiences: Two-year Reflections on Short-term Study-abroad Elective Engineering Courses

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Abstract

In response to an effort by the home institution to internationalize 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 repeat offerings in January 2013 of two distinct three-semester-unit courses in a three-week time frame in France and Australia. 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. In the second offering of each course, increased interaction with local industry was a goal. Assessment of the program was carried out through typical course evaluations, student surveys, student reflection papers, and formalized instructor observations. Overall, these CIE courses have been found to be a valuable approach in the delivery of senior-level technical electives combined with an international experience.

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 85 percent of USD's undergraduates participate in study-abroad programs.[1] There are a variety of reasons for this increase including an effort by the institution to internationalize 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.[2]

Despite a desire by engineering student to participate in international experiences, engineering students are typically underrepresented in study abroad programs. Two faculty in the engineering program at USD have developed senior elective courses in mechanical engineering and electrical engineering to be taught abroad. These courses, *Topics in Fluid Mechanics* and *Advanced Electronic Circuit Design*, were first offered in January 2010 in France and January 2011 in Australia, respectively.[3, 4] Due to the success of these courses, repeat offerings of the two classes occurred in January 2013.

As part of the development of the two courses, the concept of Compact International Experience (CIE) course was developed. CIE courses are short-term, faculty-led, study-abroad courses with the goal to combine technical engineering content with an international experience. 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.

The technical content and the international experience are assessed using a three-pronged approach. (1) 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. (2) Students write weekly reflection papers concerning their total experiences. Finally, (3) 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.

Description of the two Compact International Experience Courses

The electrical engineering senior elective course, Advanced Electronic Circuit Design (ELEC 403), was offered during January 3 to 22, 2013 dividing time between Sydney and Canberra, Australia (figure 1). 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, both hard and electronic copies were made available at no cost to the students for their private use. Each student was provided with a licensed copy of National Instruments Multisim™ 12.0 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 course met for nineteen days with thirty-five scheduled classroom hours and an additional two-hour final exam period. The lectures were conducted in a conference room at the varied locations. The students stayed, typically in rooms of two, in hotels near the main part of each city. The instructor stayed with the students in the same residences in a private room and held office hours either in that room or in a public room at the hotel. Public transportation and private coaches provided easy access to the varied locations.

Figure 1. Advanced Electronic Circuit Design in Australia

Tours and excursions included locations that were intended to be cultural (Blue Mountains Eco Tour, Sydney Opera House, etc.) and some intended to be technical (Canberra Deep Space Communication Complex, Power House Museum, Dolby Labs, 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 the engineering departments at three Australian universities (University of Technology, Sydney; University of New South Wales; and the Australian National University) where they were introduced to engineering research activities at the universities and explored opportunities for international graduate study.

Topics in Fluid Mechanics (MENG 462) was offered in Marseille, France during January 3 to 24, 2013 (figure 2). The course is a senior-level technical elective and 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. Guest lectures from students, researchers, and faculty of the host institution included topics such as vorticity in turbulent flows, an introduction to plasma physics and nuclear fusion, and Fourier analysis and applications in turbulence. The lecture on the Reynolds decomposition in turbulent flow was given to a joint group of students from the home and host institutions. The course has been offered by the instructor twice before; first in a semester-long format at the home institution during the spring 2007 and then again as a CIE course in France during the 2010 intersession.

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 Aix-Marseille Université campus at Chateaux Gombert outside of the city, but within easy reach by public transportation.

Figure 2. Topics in Fluid Mechanics in France

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 on homework (six assignments, 30% of the total grade), the midterm exam (3 hours, 4 problems, 30% of the total grade), the final project (3 different computational assignments in groups of 4 or 5 students, 30% of the total grade), and an international component (3 reflections papers, 10% of the total grade).

Group activities had technical and cultural components. A trip to the International Thermonuclear Experimental Reactor (ITER) in Cadarache was mainly technical in nature and it was accompanied by lectures on plasma physics and nuclear fusion by researchers at the host institution. A weekend trip to Paris included a visit to the Musée des Arts et Métiers, which displays many scientific instruments and inventions.

Cultural activities included visiting a variety of local attractions (Chateaux d'If, Vieux Port, Vieille Charite, Calanques), day trips to Aix-en-Provence and Lyon, 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 lessons to facilitate greater cultural immersion for the USD students were conducted by faculty, researchers, and students of Aix-Marseille Université

Instructor Observations and Course Grades

In ELEC 403, 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 and the tight schedule, homework submission was done on an individual basis. In the course of "office hours" students showed their work and computer simulations to the instructor who often made suggestions as to how to improve each: students made appropriate changes before homework grades were recorded. As a result, all the students achieved homework scores greater than 93%: typical homework grade averages for this course instructor during a normal semester lie in the 75-90% range.

Given that Advanced Electronic Circuit Design has only been offered in a compact format (either abroad or on campus as a summer course), technical comparisons are a bit 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 obtained an average grade of B (~3.0) in the prerequisite courses while the total student population averaged a B– (~2.7) in those courses. For the CIE course, the average grade was somewhat higher: A– (~3.5) with no student performing at a lower level than in the prerequisites. 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.

The technical evaluation of the three Topics in Fluid Mechanics (MENG 462) 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 2010 CIE course, 3 As and 1 B were given with an average GPA of 3.7. For the 2013 CIE course, 10 As and 3 Bs were given with an average GPA of 3.6. The GPAs are relatively high in all courses and there are two main reasons: first, both courses were senior-level electives and only students with a strong interest in the topic enrolled in the course. Second, due to the small student enrollment in the courses, a high level of student-faculty interaction was accomplished. This argument is particularly applicable to the CIE courses due to the shared living arrangements.

Student Reflection Papers

In that Advanced Electronic Circuit Design was presented in different cities (Sydney, Canberra, and the back to Sydney), it was decided to assign the reflection papers essentially on a city-by-city basis. Near 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 e-mailed to the instructor as soft copies.

Student commentary covered a wide range of topics including food, scenery, animal life, the excursions, and the course itself. Some of their general comments about the international experience are:

"I figured that Australians speak English, so there wasn't going to be too big of a difference between the places. I was extremely wrong. After stepping foot off the plane, I realized how different the culture is here. There are so many differences, large or small, that intrigues me

every day. Having never been out of the US, I feel like I was close-minded about the rest of the world. Now that I have been here for a week, I am getting a better feel for other countries, and the rest of the world in general. It makes me wonder how different other countries are."

"I also want to continue meeting the local sydneysiders to learn more about the cultural differences and life "Down Under" so that I can walk away from this study abroad experience a more informed person of the world."

"This being my first time out of the country, it has been an extremely eye-opening experience. It is immensely interesting interacting with people from a completely different culture and is a type of reality check to me. I had thought about countries outside of the United States before this class, but I had never really known what exactly to think about them. Being here makes a world of a difference and opens my eyes to the reality of how big the world really is. I think it is imperative that if a person wants to be successful in the world, it is necessary for them to see how others in the world are doing in comparison."

"I found talking with the local people to be a great part of the trip. It was interesting to hear their perspective of the U.S. Some of the Australians are amazed at the issues that America is dealing with and wander why we have not progressed beyond 1950 Euro-Christian modes of thinking."

"Study abroad in Australia has been a life changing experience so far. I have learned so much through experiencing a foreign place. It has allowed me to get out of my comfort zone and learn how to adapt to new situations."

The tours of technical sights and local engineering firms also expanded their thoughts about engineering as an international occupation:

"This has been the part of the trip that has really brought out the global aspect of engineering and science. Even though during the cold war the "space race" was billed between only the U.S. and USSR it really was a global effort for all of humanity. Without these communication arrays in Canberra and Madrid it would be impossible for the US or USSR to handle alone. Another example of the global engineering idea I saw at the museum in Canberra was a picture of the International Space Station. It had all of the parts separated and labeled by which country produced said part. Even though most were from the US a few countries that were on the chart surprised me like Brazil and Finland."

"Part of this newly found understanding comes from the different tours and adventures we have been on. The most notable one for me was the Space Center. While I had previously known that electronics was vital in space, this tour allowed me to better understand the real uses for it, and how I may be able to apply it in the future."

"Working for a company such as Dolby would be very amazing, but to also work for them overseas in another country seems almost like an imaginary dream"

"While visiting Dolby Labs, I learned that there are many Engineering related jobs available in the country, but they are extremely competitive. Dolby Labs hires few recent Bachelor Degree

Graduates, and of those few, most are either the Valedictorians or Magna Cum Lades of their class. This fact made the prospect of applying for abroad jobs a little intimidating, however the great possibility of attaining a working visa for Australia was stressed. It is good to know that if I were to eventually become in a position where I could get a job in the country, I could be easily and quickly sponsored to attain a working Visa."

The visits to the three universities expanded their thoughts about continuing education:

"Study Abroad has gave us the opportunity to visit other colleges and consider going into a graduates school. So far we have visited NSWU and UTS, two amazing school that are open for international students for both undergraduate and graduate school. Before this trip, I never thought about attending graduates school, let alone taking graduate school in another country."

"It makes me wonder if I should apply to each of them for graduate school, but at the same time I am reminded of the cost of living here in Sydney."

"Graduate school in Australia seems like a very fun opportunity."

"Each university we visited sparked interest in me if going to graduate school outside the US is a viable option."

"I love the United States, but having the abroad experience has made me hungry to travel more and experience more cultures that the world has to offer. I previously never considered working or studying abroad long term, but this experience has inspired me to research some options for working or going to graduate school outside the United States. Sometimes it is hard to think that the world can be much bigger than the small area that I work and live in, but I now I have come to realize how many amazing places and opportunities are available all over the world."

There were also comments about how the CIE experience made them think about their own lives:

"I think the most important thing this trip has taught me was not about the places we went, but the people I went there with. I had always thought relying on other people for help was a weakness. Now I see I was the one with the weakness, an inability to admit when I need help. On this trip I learned it is ok to come to a professor with questions, or ask a classmate when you are having trouble on a homework problem. I know this is stuff people learned in high school, but it finally clicks for me."

For Topics in Fluid Mechanics (MENG 462) course, three reflection papers were assigned: the first paper was due approximately half-ways through the course, the second just before returning to the US, and the last a few days into the spring semester at the home institution. The reflection papers were assigned 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 students covered a variety of topics in their reflection papers, including trip preparations, local activities, reports on class activities, or cultural observations. Overall, the opportunity for a study abroad experience was greatly appreciated: “My time spent in France was an amazing, once in a lifetime experience that I will remember for the rest of my life.” “It has definitely been a once in a lifetime experience.”

The students comment about how the experiences have impacted them: “Going back to the U.S. I am excited to see my friends and share everything that I have been able to see and do with them. I will miss Marseille, however, I am excited to see how it feels to be back in the U.S. after experiencing so many different things that I am not accustomed to. I wonder how my perspective on things will be affected. I hope that I maintain many of the changes I have adapted to as I return. All I know is that I will never forget this trip and experience.” “I realized how little I know about the world. I felt like I have been introduced to very few cultures, languages, and activities of different countries thus far.” “I feel that within the past month I have been able to gain a very accurate experience of France altogether.“ “It is extremely humbling to be put in a situation in which you cannot expect the people around you to be like the people you grew up with.” “It has been amazing to get to know everyone on such a personal level, and break the barrier of “hi, how are you, how are classes.””

The students also provided observations on the course and academic environment: “Math the Universal Language: While we have had four different lecturers teaching our material, it is incredible that even with the complex language barrier we can still learn. While math has different ‘dialects’ or notations it follows the same form (at least in the western world I do not know if I would understand Chinese notation).” “In terms of academics, I’ve really enjoyed the method of study on this trip. Since we are all leaving from the same place and taking the same transportation to school, it’s great not to have to worry about rushing to not be late for class. The flexible schedule helps, too, as class endings seem to make more sense when not confined to the 55-minute period structure at USD.” “Classes here are also a new experience. Although I am familiar with going to lecture and then a cafeteria then back to lecture, the familiarity of living in the same place as my teacher is a uncommon blessing that allows me to get to know my professor outside of just class and office hours.” “I really enjoy the University campus. Although it isn’t quite as ornate as our campus, I would hope that they would invest their money into more useful things than planters or palm trees. Like everything else here, the University is condensed.”

The course structure and student-faculty interaction were appreciated: “The final project was probably the most challenging part of the entire class, but I feel like I did learn a lot about the software while simulating boundary layers over a flat plate.” “The few hours of class each day is perfect because it gives us enough time to understand the technical part of the course, but is not overwhelming.” “The evening homework sessions are great because they allow us to recap the often large amount of technical material earlier that day, and then work on questions together. I have never worked in groups or partners on anything at USD other than required group projects, and this new approach has been wonderful for me. I feel that I am supported by both Dr. Jacobitz and the other students quite directly, as our small groups ensure that each individual understands the material being covered.” “I feel as though knowing my professor and classmates has helped

in almost every situation. It keeps me focused on school and I am able to enjoy myself more because I am around familiar faces."

Some students also reflected on a student getting sick: "I think that one of the worst case scenarios for a traveling abroad experience is when someone would end up in the hospital. When it happened to [a student], it was troubling for all of us but I'm very impressed by the way that [the instructors] and the other students handled the situation. [His] health was put as first priority for everybody and as unfortunate as the incident was, it could not have been put in more responsible hands."

A student was also mindful about the associated cost: "The financial aspect of the course was the main reason for my hesitation when signing up for the course."

Survey results

The students in each CIE class were asked to complete a survey concerning international awareness immediately before and after taking the CIE course. The survey consisted of 28 queries: 19 taken from the USD School of Leadership and Education Sciences international experience survey, 3 comparing the CIE courses to USD courses given in the traditional semester-long format and during the three-week intersession on campus, 2 queries concerning the international experience as related to engineering, and 4 queries concerning returning to a foreign country for education, work, or pleasure. The survey used a 6 point scale ranging from "strongly agree" (1) to "strongly disagree" (6) and asked for short statements relating examples from the student's own experience related to the queries. While preserving the anonymity of the respondents, individual pairs of surveys (before and after) were grouped so that individual changes in responses could be tracked.

Students started the CIE courses with high expectations when comparing them to typical courses at USD with an average score over the three questions of 2.22. Interestingly, the CIE courses exceeded their expectations, gaining almost a full pint in scoring to an average of 1.30. A full 50% of the individual responses showed gains in scoring (Figure 3).

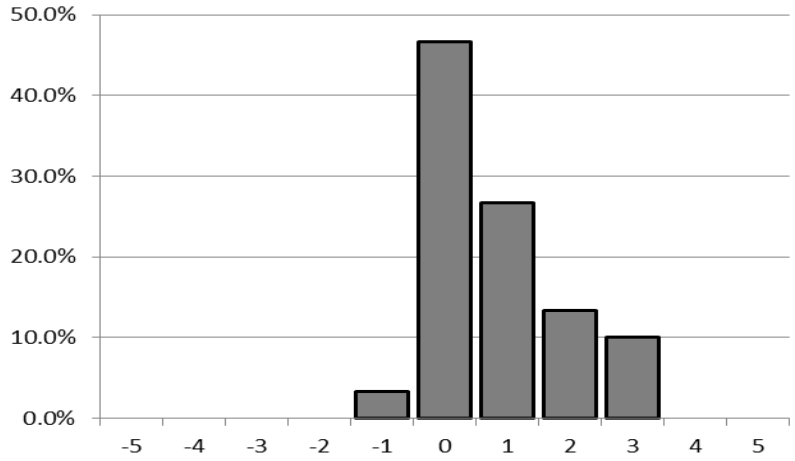

Figure 3. Incremental Change in CIE to Traditional Format Course Comparision

Students started with reasonable international awareness (2.62 average) as described in the 19 international experience queries and showed considerable gains (0.66 average) in their international awareness with 40.6% of the responses showing an increase in awareness as opposed to only 10.8% decrease (Figure 4).

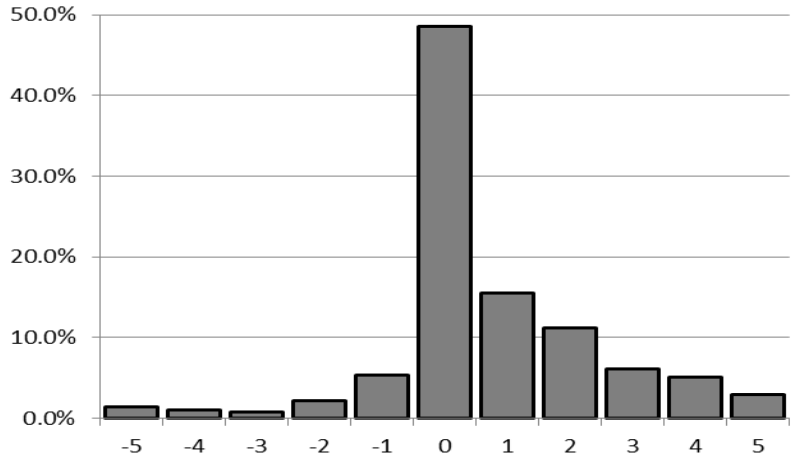

Figure 4. Incremental Change in International Awareness Student Responses

The international experience query with the largest score differentials was:

> *I have thought about why other countries may have a different perspective than the U.S. on global issues, such as agricultural production, trade, or the environment.*

Student responses to this query started out essentially neutral (3.54 average) and increased to general agreement (2.07 average) with 64% of the responses showing an increase. The incremental changes for this query are shown in Figure 5.

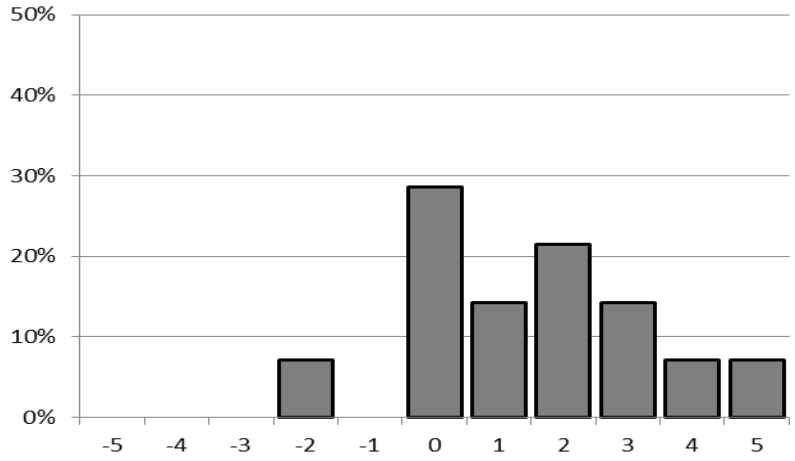

Figure 5. Incremental Change in Perspective of Global Issues Student Responses

Prior to the beginning of the CIE courses students expected the courses to enhance their engineering knowledge (1.8 average) and their understanding of the impact of engineering solutions in a global and societal context (2.11 average). Once again the CIE courses exceeded their expectations and gained in average score by 0.67 and 0.78 respectively. A full 30% of the responses showed positive gains with none showing a negative gain: 83% of the final responses were in the highest category with the remaining 17% of the final responses in the next highest category.

Students generally expect to visit a foreign country in the future (average 1.79 before and 1.20 after), but while returning to continue their educational experiences showed similar gains in scoring (an average increase of 0.61), the final mean score only showed moderate interest (2.93). Working or volunteering in a foreign country does not seem to be in the future for most of the students (average final scores of 2.87 and 3.67).

All survey queries experienced a positive change in student responses except two. *"I am interested in learning more about world geography"* experienced a slight drop of 0.20 while "*I am considering to work in a foreign country"* remained essentially constant (-0.01 differential). Students "somewhat agreed" with each statement resulting in average final scores of ~2.7 and ~2.9 respectively.

Summary

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 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.

In summary, the CIE format works well. Course instructors are on call at all times 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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