



Short-term, Full-semester, Study-abroad Engineering Programming and Signals & Systems Courses

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Abstract

Three week short-term full semester coverage Intersession courses were successfully developed by the home institution as a tool to increase student international awareness while delivering substantial technical content. Course offerings have included engineering core and engineering elective courses taught in a short-term study abroad format by home institution faculty. The success in delivering such engineering courses in a three-week format has been demonstrated [1]. New study-abroad courses in Engineering Programming required for all engineering majors, and Signals and Systems that is required for Electrical Engineering majors were developed as Intersession courses taught in London. These courses were developed to be completely portable, where required hardware and software were acquired by students prior to leaving from the home institution for the study-abroad courses for use at the international location.

The Engineering Programming class used the Raspberry Pi as the computation and programming Engine. Students used their personal computers via Virtual Network Computing (VNC) sharing system. This interfacing allows the portable personal computer as the terminal and display device for the Raspberry Pi.

The use of a Raspberry Pi in Engineering Programming allowed for instruction in C programming using the GNU Compiler Collection (GCC). The type of programming exercises were widened beyond typical computational-only programs, to sensing and actuating external devices via the Raspberry Pi's GPIO pins. The complete kit or "box" consists of a Raspberry Pi 3, power supply, case, Micro-SD Card pre-loaded with the GCC compiler and other required software, select sensors and actuators, and interface cables.

The Signals and Systems course used MATLAB as the computational software platform. In addition, the Digilent Analog Discovery 2 system was used, in conjunction with microphones, to capture audio signals for analysis using MATLAB.

Students were additionally able to expand their understanding of the impact of engineering solutions from a global and societal viewpoint with a visit to Bletchley Park where Alan Turing accomplished his breakthrough work on a deciphering the Enigma Code, and to the British Museum of Computing.

Assessment of the program consists of the course evaluation, student surveys, and formalized micro-observations.

I. Introduction

More than 75% of University of San Diego (USD) undergraduates have participated in study abroad programs. International experiences can be obtained in many different ways, including year-long or term-based study-abroad programs, summer or short-term three week long intersession study-abroad classes, or courses with an international focus taught at the home institution (USD).

Engineering students who study engineering abroad can choose to participate in year-long or term-based study-abroad programs either by directly enrolling in the host institution or through exchange programs. Courses with an international focus taught at the home institution (international experience without a passport) incur no additional cost and can provide a global cultural and engineering context [2]. Engineering programs, however, rarely offer such courses. Summer or short duration three week intersession study-abroad courses provide a balance between the two approaches and is the focus of this study.

A special concern may be that in Engineering courses abroad, special software or hardware must be used. Therefore, portable hardware and software tools must be used if the international facilities do not have the required hardware or software.

USD is strongly committed to global competence through the internationalization of its onsite curriculum and through study-abroad opportunities. USD is currently ranked second in the nation for undergraduate study-abroad participation.

The USD School of Engineering is steadily increasing participation in intersession and study-abroad courses, as well as service learning opportunities abroad. The Compact International Experience (CIE) [1] courses are a new venture that enjoys advantages of the various methods for international education. The CIE are short-term (three-week) engineering courses taught by USD faculty abroad. The courses described here are freshman and junior level CIE courses.

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. (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 CIE engineering courses are described and the hardware and software transported by students abroad are assessed with respect to student use of the hardware and software.

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: Signals and Systems (ELEC 350) was offered to electrical engineering juniors, and Engineering Programming (ENGR 121) for all engineering majors were conducted in the January 2018 three-week intersession. The two courses are described.

A. Signals and Systems (ELEC 350)

The electrical engineering required junior level course Signals and Systems (ELEC 350) was conducted in intersession 2018. The course developed mathematical modeling of physical systems with methods of analysis for linear, time-invariant systems; time-domain and frequency-domain analysis. Applications for Fourier series, and Laplace and Fourier transform methods of analysis were provided. Also covered are state variable representations, the sampling theorem, simulation diagrams, introduction to discrete-time approximations and analysis, computer-aided analysis and simulation using MATLAB.

Lectures were held at the Florida State University London Centre consisting of 14 daily classes of 3 hours each. Midterm and final exams were administered.

Of particular interest was the use of MATLAB. Prior to departing the United States, students enrolled for the intersession ELEC 350 class were required to download evaluation copies of MATLAB onto their personal laptop computers. MATLAB was used extensively in class, during exams, and in assignments to allow visualization of time and frequency domain signals and the processing of those signals.

In addition to MATLAB, the instructor brought a Digilent Analog Discovery 2 USB instrument to acquire real data (audio microphone signals) for analysis by students using Matlab during the intersession class. Students captured data using the USB instrument, altered the output data file using Excel, and then analyzed or filtered the data using MATLAB.

B. Engineering Programming (ENGR 121)

The required freshman engineering course, Engineering Programming (ENGR 121), was also offered in the three-week intersession term in January 2018. The course provided students with instruction on the use of C language for engineering problem solving. The hardware platform was the Raspberry Pi 3B running the Raspian Operating System. The compiler used was the open source Gnu Compiler.

In addition to the standard computer language topics (including an introduction to Linux), students used the Raspberry Pi to interface with hardware (LEDs). The Raspberry Pi was connected via Virtual Network Connection (VNC) to personal computers that were used as the terminal and keyboard devices. The use of the Raspberry Pi as a platform for teaching allowed for instruction in some hardware Input/Output aspects in addition to standard programming topics.

ELEC 121 met for an average of three lecture hours per weekday. The lectures

were conducted in a classroom at the Florida State University London Centre in London.

Non-classroom international activities included visiting a Bletchley Park (home of the Enigma decipher), National Computing Museum, the Faraday Museum at the Royal Institution, Oxford University, and a Shakespearean play. The students also used afternoons and evenings for a further exploration of the city and its surroundings.

III. Assessment and Results

In the following, student experiences of the courses are assessed, with some attention to the hardware and software transported and used in London.

A. Assessment of course delivery by teaching evaluations

Short questionnaires were designed to provide insight on the student level of knowledge of the subject matter and confidence in applying the software and hardware concepts. To provide further insight on actual student knowledge level, students were asked to respond with a short answer to the knowledge questions. In order to track individual student incremental changes, each survey was coded with a secret number, thereby preserving student anonymity. The use of student-assigned scores to assess gains in student knowledge and confidence has been successfully used by the investigator team in previous studies by Schubert, et. al. [1].

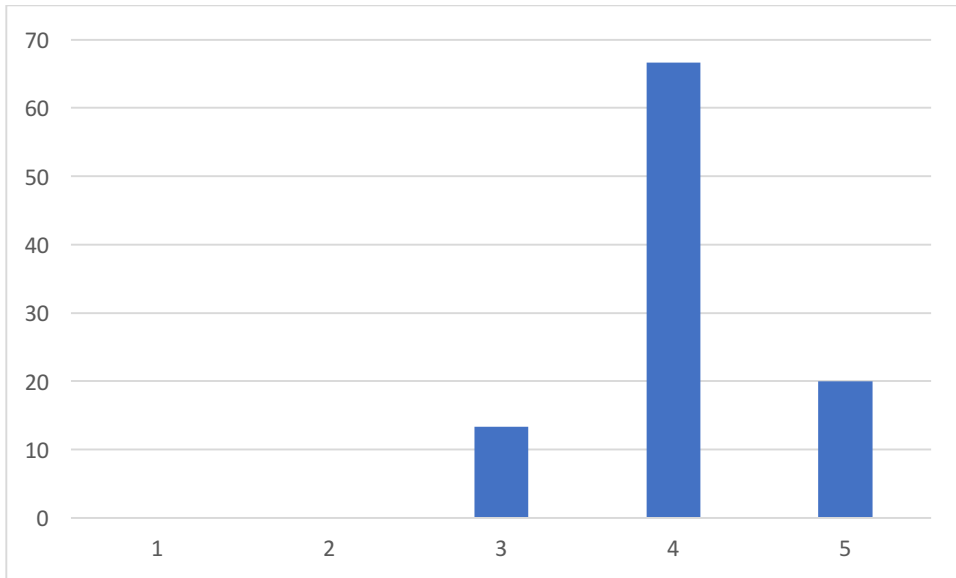
The following four questions concerning confidence were asked of both ELEC 350 and ENGR 121 courses:

1. How do you start the software to solve a problem?
2. How do you hook up the hardware to solve a problem?
3. Can you solve problems using the hardware and/or software that you brought with you for the study abroad course?
4. Did the course location and short term nature of the course help your learning experience?

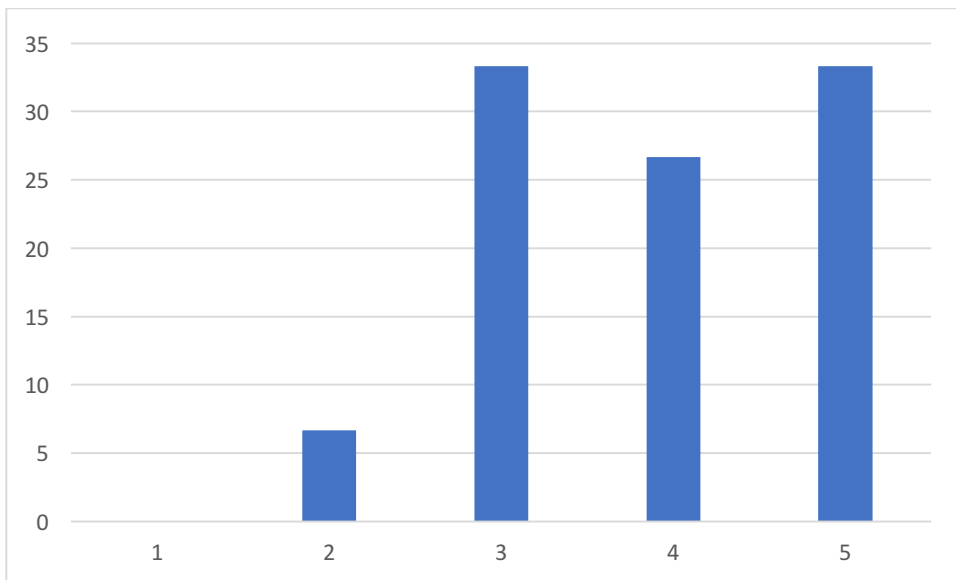
The knowledge score was based on the following scale:

- 1 = No Clue, I have no idea if I can apply the concept
- 2 = Low, I have heard of the concept, but have little confidence that I can apply it
- 3 = Moderate, I think I understand the concept, but am unsure about applying it.
- 4 = High, I am fairly sure I understand the concept and am fairly sure I can apply it.
- 5 = Superb, I am very confident that I understand the concept and can apply it to a new problem

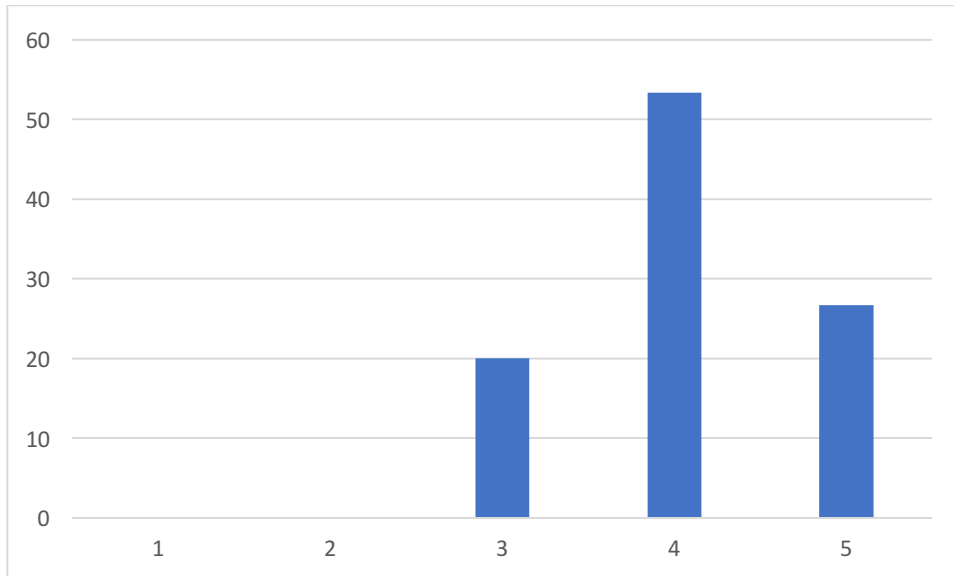
The results of the Intersession knowledge survey follows:



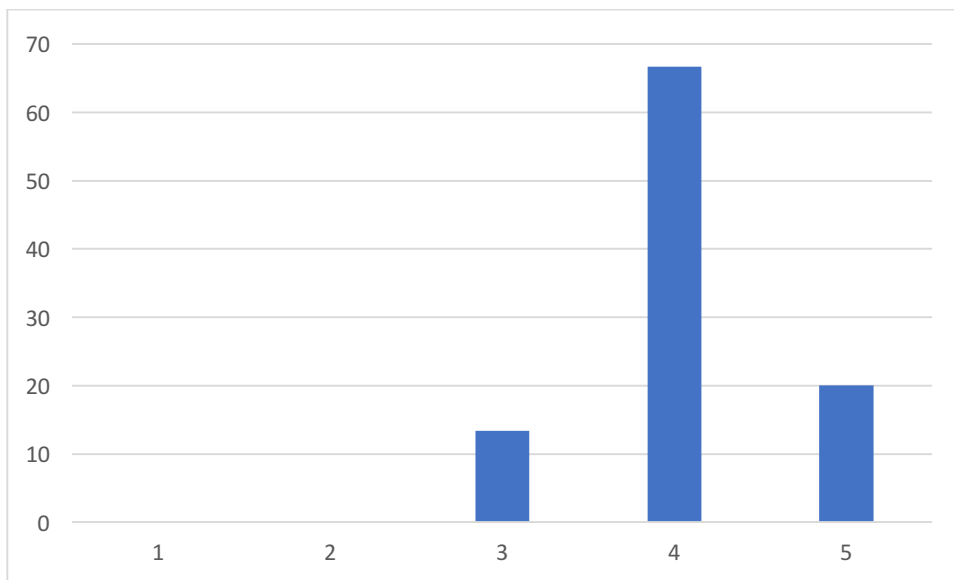
How do you start the software to solve a problem?



How do you hook up the hardware to solve a problem?



Can you solve problems using the hardware and/or software that you brought with you for the study abroad course?



Did the course location and short term nature of the course help your learning experience?

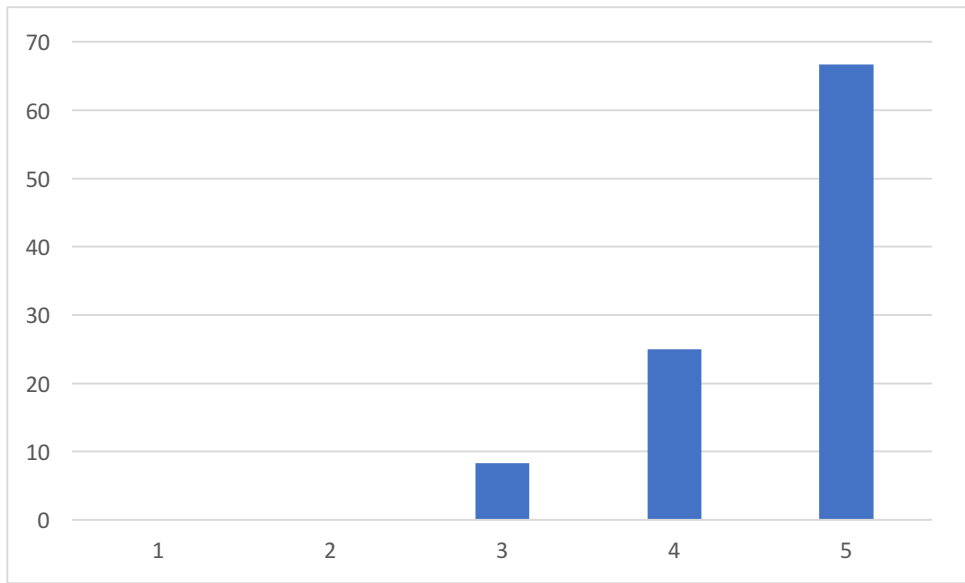
Another portion of the questionnaire was designed to assess student confidence concerning the study abroad course:

1. I can use the software and/or hardware required for the course.
2. I can use the software to solve problem assignments.
3. I can use the hardware and software to solve problem assignments.
4. Given the short-term study abroad session, how confident are you that you will retain the course material?

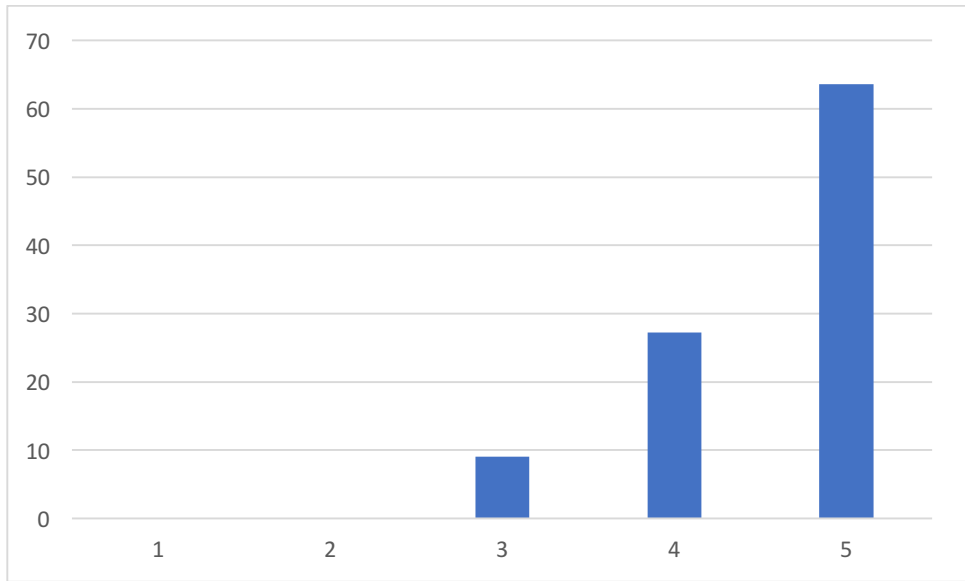
The confidence score was based on the following scale:

- 1 = No clue, this concept is new to me
- 2 = Low, I have only heard about the concept
- 3 = Moderate, I know about the concept, but have not applied it
- 4 = High, I know the concept and have tried it
- 5 = Superb, I know the concept and have successfully applied it

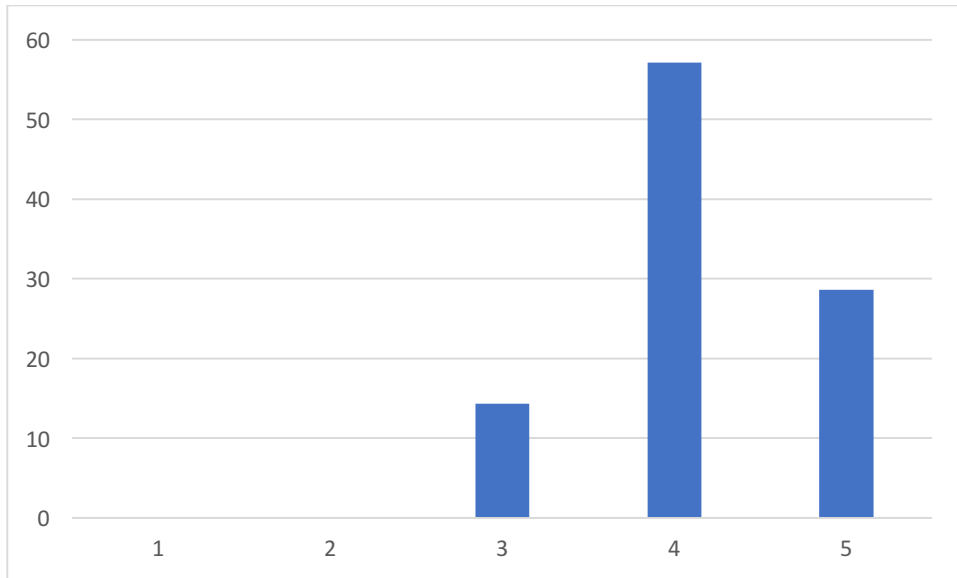
The distribution of students' answers on their confidence after the Intersession 2018 are shown below.



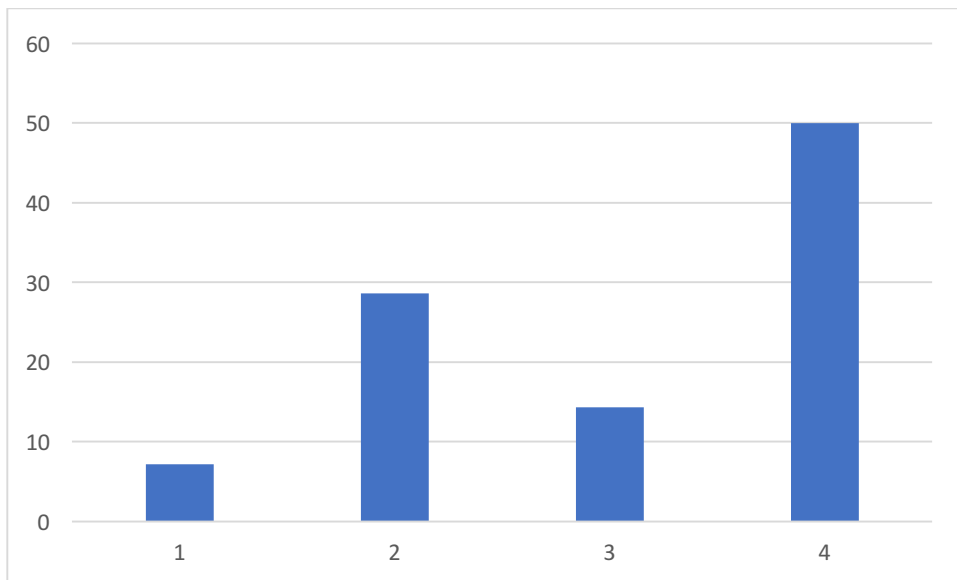
I can use the software and/or hardware required for the course.



I can use the software to solve problem assignments.



I can use the hardware and software to solve problem assignments.



Given the short-term study abroad session, how confident are you that you will retain the course material?

IV. Summary

The use of student transported portable hardware and software in a freshman Engineering Programming course (ENGR 121) and electrical engineering Signals and Systems course (ELEC 350) was studied.

Summary scores for students' knowledge using the hardware and software brought to the international location was an average of 4.02 with a standard deviation of 0.09. The overall level of confidence that students had using the hardware and software brought to the international

location was an average of 4.31 with a standard deviation of 0.23. These results indicate that students had a good grasp of the hardware and software that they brought to the international site.

Detailed course outlines and syllabi will be included for presentation at the conference.

References

- [1] Thomas F. Schubert and Frank G. Jacobitz, "Compact International Experiences: One Path to Expanding Student International Awareness Through Short-Term Study-Abroad Elective Engineering Courses", Proceedings of the 2011 ASEE Annual Conference and Exposition, Vancouver, BC, 26 June 2011
- [2] Solomon R. Eisenberg¹, Jo-Ann Murray¹ and Urbain DeWinter, "Developing a Study-abroad Opportunity for Engineering Undergraduates," Proceedings of the 2003 American Society for Engineering Education Annual Conference & Exposition