Building international capability through on-line collaboration

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ABSTRACT: In the near future, international collaboration will include globally distributed engineering teams. Remote laboratories (RLs) offer a unique learning environment, where students can remotely access and perform experiments on real equipment via the Internet in a similar way as future engineers conducting their job all over the world. One certain advantage is the opportunity RLs offer for students' collaboration, internationally. This is rather difficult with conventional laboratories. This paper presents a case study of international on-line collaboration in a remote laboratory (NetLab) at the University of South Australia (UniSA), a project supported by the Australian Learning and Teaching Council (ALTC) Competitive Grant. The remote collaborative experiment was conducted by teams of students consisting of students from Australia and Singapore. The paper includes students' feedback regarding their collaborative international experiments. Experiences from this project are expected to set the ground for the development of future remote laboratories as collaborative learning environments.

INTRODUCTION

The trend towards globalisation goes hand in hand with the development of Internet technologies that support international communication and collaboration. It is fair to expect that international collaboration will soon include both globally distributed engineering teams and globally distributed engineering systems. Consequently, engineering graduates will be highly valued by employers if they have both good international collaboration skills and experience in intercultural communication. This requires rethinking of engineering curricula but also the development of modern technology that supports on-line collaborative environments, and training students in using them. Remote laboratories (RLs) offer a unique hi-tech learning environment, where students can remotely access and perform experiments on real equipment via the Internet. RLs are the latest developments that are reshaping the way in which courses with a practical component are conducted. They already show some advantages over the real and virtual laboratories and are emerging as the laboratories of the future. Unlike traditional laboratories, RLs offer the opportunity for international student collaboration. The preparation of students for emerging forms of interaction that will characterise their future profession will be immensely important to their practice. This paper presents experiences with international on-line collaboration in the NetLab remote laboratory at the University of South Australia (UniSA), a project supported by an Australian Learning and Teaching Council (ALTC) competitive grant of AU$220,000 over the two-year period, 2009-2010. The project involves four partner institutions: two from Australia (UniSA and the University of Technology, Sydney (UTS)) and two international partners (Faculty of Engineering, University of Porto (FEUP), Portugal, and Blekinge Institute of Technology (BTH), Sweden). Experiences from this project are unique and are expected to facilitate the development of future remote laboratories as collaborative learning environments.

COLLABORATION VERSUS COOPERATION

Students' collaboration and cooperation skills are developed by conducting projects that involve a joint intellectual undertaking by the students or students and their teachers. Collaborative learning or cooperative learning are types of situated learning that include group activities with particular emphasis on cooperation rather than competition among students. These types of activities require students to develop additional skills such as the ability to work and communicate effectively in groups. Cooperative learning is distinguished from collaborative learning. In cooperative learning, teachers take most of the responsibility for decisions about the subject matter and how the groups are to cooperate, while in collaborative non-competitive learning group activities, students are engaged in making decisions about what is learned and how [1]. Collaborative learning has been defined in a number ways, but it is generally understood to refer to small group learning, where the group members actively support the learning processes of one another [2]. The introduction of the Internet has contributed to the further development of cooperative international or global learning environments [3]. The collaborative learning environments range from the small group learning

confined to the classroom or laboratory to the advanced cyber space domain, where the computing and information technology have increasingly assumed a dominant importance [4].

ALTC PROJECT

The authors were awarded an ALTC grant for a project entitled *Enriching Students' Learning Experience through International Collaboration in Remote Laboratories* [5]. The project involves the development, implementation, evaluation and consequent dissemination of students' international collaborative activities in RLs. The expected outcomes include the development of students' international and intercultural perspectives, a framework that would best support the intercultural communication and international collaboration in RLs. The School of Electrical and Information Engineering (EIE) at UniSA has been running a very successful transnational program in Singapore with the APMI Kaplan institution. The initial experiment was conducted with four groups, each consisting of two students from Adelaide and two students from Singapore [6]. These four groups conducted the same remote experiment as the onshore students in Adelaide and the offshore students in teams consisting of Singapore students only, in the first semester 2010. In the case of the four groups, the students were separated in time and in location. The success of their experiment required real global collaboration.

THE REMOTE LABORATORY NETLAB

The NetLab remote laboratory was first developed in EIE at UniSA in 2002 and has been enhanced since then [7]. It can be accessed at http://netlab.unisa.edu.au. It is currently used by onshore students in Australia, as well as offshore UniSA students in Singapore and Sri Lanka, who collaborate in conducting remote experiments. The real physical laboratory is located in the Sir Charles Todd Building at the Mawson Lakes campus of UniSA. A picture of the NetLab is shown in Figure 1. Technical details are included in previously published papers [8][9]. A brief description of the RL follows. The real components and devices can be remotely controlled by users via the Internet. The components are resistors, capacitances, inductances and a transformer. All components (apart from the transformer) are variable components and their values can be changed by users via the Internet [10]. On-line wiring is also available via *Circuit Builder* special software [11].

The available devices are a digital oscilloscope, a function generator and a multimeter. All of them can be fully controlled on-line. All data from the remote experiment can be downloaded to the user's computer for later processing and analysis. All actions in the real laboratory can be viewed via the Web camera with the zoom, tilt and pan features being fully controllable by the user. The RL has a very sophisticated dynamic booking system, which allows up to three users to book their time for the experiment in a one hour slot allowing for active collaboration. The collaboration is supported by a chat window included in the main NetLab Graphical User Interface (GUI), as well as by an audio communication.

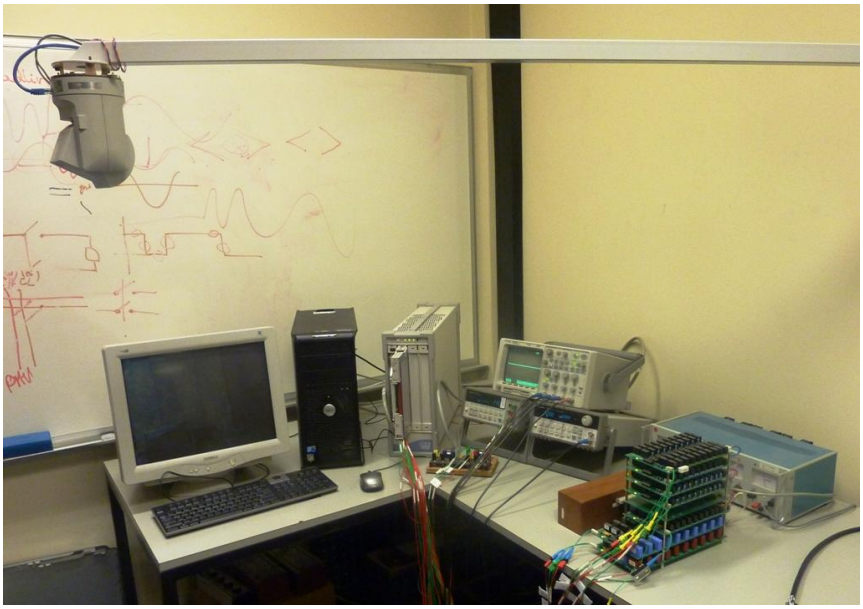

Figure 1: The remote laboratory NetLab in November 2010.

THE REMOTE PROJECT

The first objective of the chosen experiment was to test a real third-order system using the NetLab remote laboratory. The students compared measurement results obtained remotely with two simulation models using PSpice and MATLAB. An example of the graphical comparison from a student's report is shown in Figure 2.

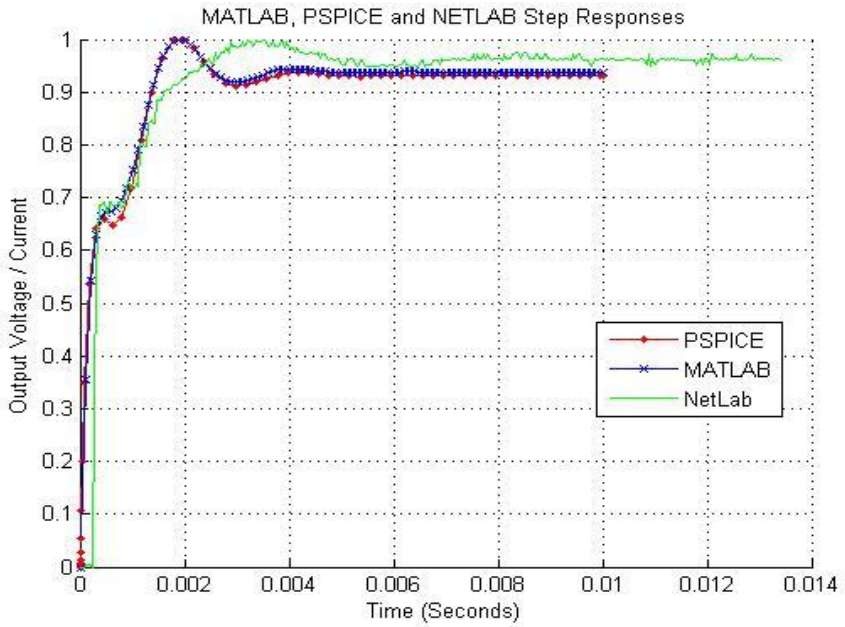

Figure 2: Graphical comparison of responses.

All student groups had to conduct the three stages of the project. First, they had to go through the pre-experiment stage, which included the detailed preparation. The second stage was the actual remote experiment, and the third stage was the post-experimental stage, which consisted of the analysis of recorded data, simulations and writing the final report. All stages required the collaboration of students and successful communication between them. The picture of a student's monitor with the NetLab GUI is shown in Figure 3. It shows parts of the GUIs of the digital oscilloscope and the function generator and the camera window.

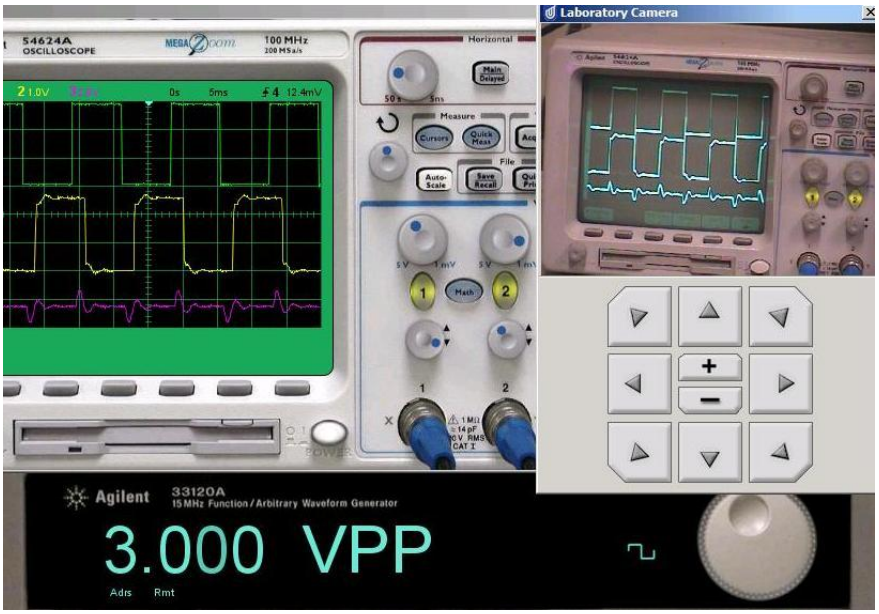

Figure 3: GUI with the oscilloscope, the function generator and the camera.

STUDENTS' FEEDBACK AND RECOMMENDATIONS

At the completion of the remote experiment all students were required to complete standard questionnaires. Questionnaire collection and analysis has continued since the first introduction of remote experiments into electrical engineering courses at UniSA. Question 13 of the questionnaire was of most interest to the authors:

What did you like the most about NetLab and what did you not like?

The students' responses to this question have helped to implement many improvements and additional features to the remote laboratory during the last 8 years. Question 13 continues to be the most important for possible improvement of the remote engineering system. Here are some of latest responses from the students' questionnaires to the question from year 2010:

1. *We applaud the creators of NetLab as the feeling of using it was similar to being physically present in an actual lab. NetLab is very good software that allows lab simulation in the comfort of your own home.*
2. *What I don't like the most is that other students can change my settings and I have to redo them. Time can be wasted. A good thing is that if I really do not know what is going on, other students can help by doing and I can learn from seeing what they have done on NetLab.*
3. *It's a useful tool to access like a real laboratory. But I dislike it when partners using the oscilloscope suddenly change settings while I have almost completed my work, and everything is wasted.*
4. *What I like most is that it is easy to access; what I dislike most is the down time when there are technical failures.*

Students in the four Australian-Singaporean international teams were asked to answer a few questions in addition to the standard questionnaire after the submission of the students' final reports and after their practical marks were known.

Face to face interviews were conducted with each group of students separately in Singapore and Adelaide as the authors felt that the responses in these interviews might yield more valuable feedback than being restricted to electronic feedback. Below is a list of the questions asked, a brief summary of students' responses and suggestions for possible improvement of international collaboration.

Question 1:

What was the main problem(s), if any during your online collaboration?

1. The leadership

   This was the most common and major problem for most groups. The group leaders were appointed by the project leaders and all of them were Australians. Singaporean students felt there was an unfair procedure in place, as many of the Singaporeans were older and some of them had a successful industrial career of more than 15 years.

   The Australian students were more efficient in applying the theory into practice, but Singaporean students were more hard working by trying to solve any problem as soon as possible, i.e. during the experiment, during analysing the data and when writing reports. In all groups all participants accepted the appointed leader, but the common feeling was that the decision of choosing the leader should not be forced on them, but to be left up to the group.

   This is a very important issue. In the future, when the global distributed team of engineering specialists is to be formed, it could be a critical decision to choose a leader, who should be accepted by other top professionals. It is also relevant to question 13 above, when students were complaining about interference from other students during their remote experiments. In the future booking system, only one student at a time will be in control of all actions, but he/she should be able to delegate this privilege to other students.

2. The time difference

   The time difference was a common problem. As students in Singapore work full time they could not perform the remote experiments at the same time as their Australian participants. The problem was often solved when the Australian participants were willing to sacrifice their night time for the project.

3. The training in software used - Centra®

   The Centra® software was used mostly for the recording of communications and actions between the students in the international collaborative remote experiments. The Australian students were trained in how to use the software and they were asked to train their international partners as a part of their project. This was a complete failure. Most of Singaporean students complained about this. Unfortunately, the Australian students were not effectively trained in how to train or teach other students.

4. Communication

   Communication is the crucial part of any global collaboration. First, the language of collaboration must be accepted by all parts of the project and participants should be fluent in it. It was not precisely so in the case of one group, when the answers for most questions were only *yes* or *no*.

   All participants preferred to use the audio communication rather than the typing in the chat window incorporated in the NetLab GUI. Some of the students also reported that the use of contemporary communication devices like iPhones, etc, was very useful. For successful future global collaboration, the use of audio and video is probably inevitable.

5. Technical problems

   The NetLab is a unique system that requires little technical support and restarts itself automatically once power is restored after the failure. All components and devices are protected against faulty connections or wrong setting of apparatus.

6. No help available

   Only a few students complained about the lack of on-line help. This was intentional omission, as it creates the real life engineering scenario, when the real engineer has to find the solution for the problem without any external help being available. Some students used up-to-date search on-line technology and were able to find similar experiments, but not in the remote mode, at different universities, internationally.

Question 2:

If any problems, how did you try to solve it (them)?

1. We have to solve them by ourselves

   Students' responses to Question 2 were very similar in all groups. Without help from academic staff, students had to solve problems by themselves. Some students in Singapore commented that it was quite different from their previous tertiary studies, where they were given detailed instructions in the form of cookbooks in the pre-experiment stage.

   In the experiment stage, they were supervised and they could ask for help and they received it. The collaborative remote experiment was quite different in the way they had to find the solution to any problem they encountered, otherwise they could not continue. After they successfully finished the whole experiment and the final report, they realised that they gained or greatly improved their independent learning skills. Most of the students were really proud of their work.

2. To solve problems we had to communicate extensively

   Students really appreciated the international collaboration. After some slow starts in some groups, they began to be confident in communication with their international partners and they solved many problems together mostly via verbal communication using their headsets.

Question 3:

What kind of advice would you give to students (colleagues) for the international collaboration online?

1. Choose your leader first and then follow his/her instructions

   The role of the leader was the most important aspect for most of the students. They valued the discussion during the pre-experiment stage, but the discussion had to be coordinated or chaired by one person. Even more important was the role of the leader during the experiment. As the NetLab collaborative remote experimental environment allows all connected users to control devices and to change to configuration of the circuit, all actions must be coordinated by one person only.

   The leader should ask involved students to do different tasks. All comments should be shared, but only the leading person should choose the next steps. In the post-experiment stage after splitting tasks, all created documents should be shared by all participants, but only one person should compile all contributions and create the final version of the report.

2. Do not be afraid to ask questions

   A very important aspect was revealed in students' responses. To achieve a quick progress in all stages of the remote project, participants must not be afraid to acknowledge that they do not understand some components of the project. They should be able to ask relevant questions, which could be answered by other students.

3. Split tasks amongst the group members

   All groups conducted the whole remote project in a similar way. They split tasks into the pre-experiment and post-experiment stages. The timing for the compilation of all parts was crucial. If one part had not been ready in time, the progress of the whole project stopped. During the remote experiment students usually split tasks again. Only

one student was responsible for the configuration of the circuit, but the other students were watching. Later each student was assigned the control of one device or component. The whole collaboration was controlled by the leader, who after discussion with all participants, made a decision about who will do what. This was a scenario very similar to the global international on-line collaboration.

4. You can learn from your international partners

   Students acknowledged they learnt many things from their international partners; not only on the professional site, but more widely than that. Most of students started to socialise and they learnt many interesting things about their different countries and different cultural environments.

5. Be patient

   Some students commented on the progress of the whole project. As some parts of the pre-experiments preparation were still missing, students attempted to conduct the experiments without them. This contributed to the failure of the first attempt of the remote experiment. Patience and a complete solid preparation for any action was the key to the success.

Question 4:

Any additional comments?

Students were very glad that they had the opportunity to participate in the ALTC project. They were very proud of their achievement. During the project they increasingly began to compete for best marks with other teams onshore and offshore.

CONCLUSION

The remote project conducted by four international groups was a great success. All four groups received final practical marks that were better by about 10% then their onshore and offshore colleagues. The decision to conduct interviews instead of the usual hand-written or electronic questionnaires was very beneficial as a more comprehensive feedback was received.

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