

AN INTEGRATED APPROACH TO DESIGN AND DELIVERY OF BIOMEDICAL ENGINEERING COURSE

Lu Hongli, Jaichandar Kulandaidasan Sheba, Christopher Teoh Eng Leong

Singapore Polytechnic

ABSTRACT

The benefits of getting students to understand how a module's subject matter is relevant and can be applied to the real world is well appreciated. Not only will the motivation to learn be heightened, the learning that takes place will also be deeper. At the same time, if we can also succeed in getting learners to connect content between different modules in a meaningful and holistic way, then students will no longer see modules in silos, but as all parts of a meaningful whole. The perspective that students will have of the discipline of study will also be broadened.

This paper examines how we have revamped the teaching of the 3rd year Biomedical Engineering option of the EEE program in the Singapore Polytechnic by integrating the teaching of 3 existing modules. Unlike the traditional way of teaching each module separately, we sought to integrate them by using a series of scenario based case studies while at the same time preserving each module's aims and coverage. Each case study lasts 1 to 2 weeks in duration. In this time, students cover the subject area of the 3 targeted modules relevant to the case through a combination of lectures, independent group research work, presentations and laboratory sessions. The lab space was also redesigned into "clinics" to provide a more authentic learning experience for the students.

This paper details the methodology used in designing this integrated program.

KEYWORDS

Scenario based case study, integration of engineering modules, authentic learning experience

INTRODUCTION

School of Electrical and Electronic Engineering (EEE), Singapore Polytechnic, offers Biomedical Engineering option to second and third year students who study in Electrical and Electronic course. This option aims to provide students with a broad based engineering foundation to support a wide spectrum of

activities in the biomedical science industry in Singapore. After completing this course, students would be knowledgeable in the areas of installation, commissioning, testing, maintenance, and sale of biomedical equipment and other electronic instruments.

Three core biomedical related modules, namely Biomedical Equipment and Engineering Practice (BEEP), Medical Imaging and Image Processing (MIIP), Medical Informatics and Telemedicine (MIT), are offered to third year students.

BEEP module aims to familiarize the students with different types of medical tools and equipment used in hospital. Students also learn about the common medical equipment characteristics, the nature of data measured and the general concept of designing equipment and equipment maintenance practices. MIIP module provides students with knowledge of various medical imaging modalities, such as ultrasound, X-ray, CT and MRI. It also teaches students basic image processing techniques. MIT module covers the information systems in the field of medicine, particularly in the hospital environment. It also covers telemetry and telemedicine system. Students learn how to physically implement an enterprise-wide network for a hospital as well.

These three modules were taught separately using the conventional methods like lecture and practical session before. The feedback from students during our dialogue session was that they did not really see the relevance of these modules and link between these modules in real world even though the importance of these modules in finding a job in the biomedical industry or to pursue higher education in university. The students acknowledge and appreciate the technical contents and its usefulness but they find it difficult to understand connection between these modules in terms of application in biomedical industry. This has caused a lack of motivation among students. Students found it difficult to understand many so called unrelated concepts between these modules even though they may have a strong link in application.

To address the above concerns, which are quite common in some of the engineering modules, we have revamped the three biomedical modules using an integrated approach. By using this integrated approach, students will no longer see these modules in silos, but as all parts of a meaningful whole.

Since these three modules find direct and common application in medical hospitals, we have design a journey to the hospital and identified six major medical departments to focus our integrated learning methods. The six medical departments are cardiology department, radiology department, clinic, rehabilitation department, biomedical engineering department and operating theatre. During the journey to each department, we use one scenario based case study to integrate the content of the three modules naturally.

AN INTEGRATED APPROACH – SCENARIO BASED CASE STUDY

In the integrated approach we have worked out a series of scenario based case studies to integrate all the content in the three modules' content, while at the same time preserving each module's aims and coverage. On the journey to each medical department, we created one scenario based case study which lasts one or two weeks in duration. In each case study, students are exposed to the subject area of the three modules (BEEP, MIIP and MIT) relevant to the case through a combination of lectures, independent group research work, presentations and laboratory sessions. Table 1 shows the teaching schedule and a series of case study.

Week	Hospital Department	Integrated approach (Scenario based case study)
2,3	Cardiology Department	Heart attack case study
4,5	Radiology Department	Brain tumor case study
6	Clinic	H1N1 case study
14	Rehabilitation	Frozen shoulder case study
15	Biomedical Engineering Department	Hospital network setup meeting
16,17	Operation Theatre	One complex surgery case study

Table 1. Teaching Schedule and scenario based case study

A SCENARIO BASED CASE STUDY

For example, in cardiology department, we use the following case study: Marcus, 62 years old, suffered heart attack at home. Following the process of rescue, diagnosis and treatment, students are exposed to medical equipment like defibrillator and ECG machine, imaging modalities like ultrasound imaging, x-ray and angiography, hospital information systems like HL7 and ICD.

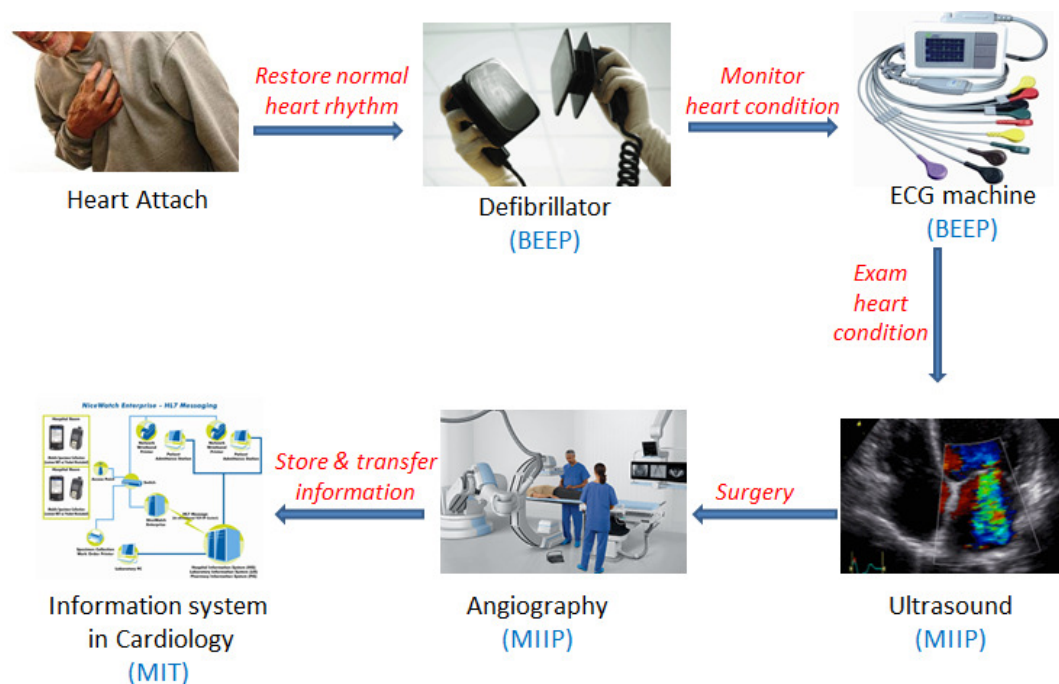


Figure 1. A scenario based case study used in Cardiology Department

INTEGRATED PROJECT

A unique approach to the use of Project Based Learning to develop CDIO skills can be achieved through the use of carefully selected project for the biomedical engineering modules. In the integrated approach, we also designed a few project based learning activities. Students are divided into groups of 3 to 4 persons. Each group is given a scenario related to different health-related problem. Students need to do research work on the diagnosis, treatment and post recovery journey, understand various diagnosis and treatment equipment, imaging procedure involved, and develop a simple solution for home monitoring. At the end of the project, students need to give a presentation and demonstration of their project.

AUTHENTIC LAB SUPPORT

Theory learning without any assistant practices is ineffective because there are many nuances, exceptions, and subtleties to be learned in practical environment^[1]. Therefore, learning from practice is the same important as acquiring knowledge and applying it into practices for engineering students. To better facilitate the integrated learning, our lab space was also redesigned into "clinics" to provide a more authentic learning experience for the students.

We redesigned two conventional laboratories and combined them into one learning space. The centre area is used for students study and group work. On the two sides of the labs, we designed four mini-show case medical departments corner. They are cardiology, clinic, operation and rehabilitation. In each department corner, students will complete the hands-on experiments covering from equipment, imaging modalities, to information system.

For example, in cardiology corner, students have hands-on experiments on medical equipment like defibrillator, ECG machine and ultrasound scanner. They also practice on the medical data and image acquired from ECG machine and ultrasound scanner from previous hands-on session. Figure 2 shows the authentic lab layout and experiment conducted.

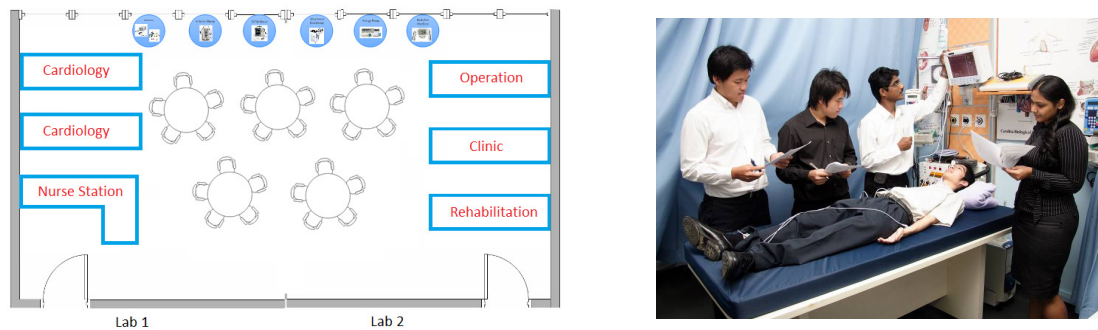


Figure 2. Authentic lab layout and experiment

CONCLUSION

This paper puts forward a method on how to revamp the teaching for the 3rd year Biomedical Engineering related option by integrating the existing modules using scenario based case studies while preserving the aims and content of each module, simultaneously. The authors hope that the teaching and learning of modules using integrated projects and authentic lab space would motivate teaching staff and students to explore collaborative learning.

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Biographical Information

Lu Hongli is a Senior Lecturer in the School of Electrical and Electronics Engineering. Her teaching focuses on biomedical engineering, sensors and instrument design. She currently works on the integration program of biomedical engineering modules offered to Electrical and Electronic students.

Jaichandar K S is a Senior Lecturer in the School of Electrical & Electronic Engineering of Singapore Polytechnic. His teaching focuses on Biomedical Engineering and Computer Networking. Jaichandar's research interests include designing Medical Devices and writing Application software.

Christopher Teoh is a Senior Lecturer in the School of Electrical and Electronics Engineering and the Manager for the School's Teaching & Learning Unit. His current research interest is in the innovative use of different teaching methods, technology and assessments to encourage active learning.

Corresponding author

Lu Hongli
School of Electrical and Electronic Engineering
Singapore Polytechnic
500 Dover Road
Singapore 139651
+65 6879 0636
LuHL@sp.edu.sg