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Case Study of Improvement of Engineering Communication Theory as Core Course to Fulfill EAC and MQA Requirement

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Abstract: In purpose of engineering program accreditation, the Engineering Accreditation Council (EAC) requires a list of compulsory subjects that need to be incorporated according to respective academic programs. The inclusion of these subjects precisely known as core subjects contained in their accreditation manual is also in agreement with Washington Accord requirement. As for this reason, the Department of Electrical, Electronics and System, Faculty of Engineering and Environmental Built of Universiti Kebangsaan Malaysia has aggressively implementing steps to improve the program, especially at the course level aimed to obtain full accreditation and achieving excellence. Course improvements will consider important elements such as delivery method, course syllabus, methods of assessment and measurement, generic competency and others taking into accounts suggestions from stakeholders such as Industrial Advisor Panel (IAP), industrial representatives, alumni and students. This study presents and discusses the improvement measures carried out for KKKL3173 Communication Theory course which is a core subject for Bachelor Degree in Microelectronics program. Researchers highlight the activities that have been carried out to enhance the effectiveness of teaching and learning by means of quiz-students pre assessment, projects-ethics, professionalism and collected technical, presentation-improving through open critic, technical visit, technical seminar, seminar on ethics and professionalism, industrial, embedded laboratory to course, questionnaire/survey.

Key words: Core course, improvement, delivery method, assessment method, EAC, MQA

INTRODUCTION

Part of the essentials of Malaysia Qualification Agency (MQA) (Fahmi, 2006) and EAC (Engineering Accreditation Council, 2007) that conform with the industrial requirements are:

- Application and cultivation of Outcomes Based Education (OBE) in teaching and learning practice of an academic program where the performance is measured based on the obtained outcome
- Constant update of course curriculum so that it fulfills the industrial requirement and technology advancement
- Exposure of students on professionalism and ethics toward society and environmental well being as well as industrial requirement
- Sensitivity of an academic program on remarks/critics aired by concerned parties and implementing changes/improvement actions immediately

Therefore, the Department of Electrical, Electronics and System of Universiti Kebangsaan Malaysia has taken the initiatives of program improvement for its undergraduate Academic Programs (AP). Fundamentally, the department offers three undergraduate academic programs; Bachelor Degree in Electrical and Electronics Engineering (EE), Bachelor Degree in Computer and Communication Engineering (CC) and Bachelor Degree in Microelectronics (μE) headed by the Head of Department and assisted by a program coordinator for each program. The program coordinators chaired the Curriculum Review Committee (CRC) for every program while the Head of Department lead this committee at departmental level. A great collaboration and team work among the HOD, AP coordinators and CRC committee members is needed to create a world class and outstanding academic programs. Cognitive engineers need to learn various skills such as how to frame research questions, conduct cognitive task and work analyses, conduct experimental studies, develop experimental testbeds and analyze both field data and statistical data. Further, cognitive

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engineers need to understand concepts such as human information processing, the human-centered design process, cognitive task analysis, cognitive modeling, human-automation interaction, individual and team decision making, situation awareness, human error, human-computer cooperative problem solving, decision support and the effect of artifacts, procedures, tools and communication on patterns of behavior. It is well known that different teaching, communication and learning activities support different learning styles (Felder and Silverman, 1988). Thus, courses that use real world examples and involve students in the courses through individual and group practice-oriented lab exercises, oral presentations, written assignments and course projects encourages situated and active learning, by hearing, applying and practicing skills. For this panel, cognitive engineering faculty from four universities share several exercises and demonstrations that they have found to actively and effectively involve students in learning some of the concepts and techniques described before (Guerlain *et al*., 2001).

This study discusses on the strategies towards excellence of the undergraduate programs giving details on improvement measures at course level aimed for full accreditation. The core course is KKKL3173 Communication Theory which is compulsory for all students of year 3. The first measure is the process of benchmarking the course contents. Researchers proposed also several delivery methods to achieve the teaching and learning effectiveness in the teaching course.

STRATEGIES TOWARDS COURSE EXCELLENCE

Students learn in many ways by seeing and hearing; reflecting and acting; reasoning logically and intuitively; memorizing and visualizing and drawing analogies and building mathematical models; steadily and in fits and starts. Teaching methods also vary. Some instructors lecture, others demonstrate or discuss; some focus on principles and others on applications; some emphasize memory and others understanding. How much a given student learns in a class is governed in part by that student's native ability and prior preparation but also by the compatibility of his or her learning style and the instructor's teaching style. Mismatches exist between common learning styles of engineering students and traditional teaching styles of engineering professors. In consequence, students become bored and inattentive in class, do poorly on tests, get discouraged about the courses, the curriculum and themselves and in some cases change to other curricula or drop out of school. Professors, confronted by low test grades, unresponsive or hostile classes, poor attendance and dropouts know something is not working; they may become overly critical of their students (making things even worse) or begin to wonder if they are in the right profession. Most seriously, society loses potentially excellent engineers (Felder and Silverman, 1988). Therefore, delivery method is very important to ensure the objectives of learning are achieved and at the same time its motivating. It is important to vary the teaching activities with somewhat different with the common learning activities such as talk on entrepreneurship/ethic/professionalism, industrial invited lecture, embedded laboratory, technical visit, technical seminars and others. This will lead the motivation among the student to give more commitment on their studies.

Course content benchmarking process: KKKL3173 Communication Theory is a core course of Digital and Analog Communication Theory. Table 1 shows the details of the course contents which consist of introduction to Digital and Analog Communication Theory, Digital and Analog Modulation System Theory, the application of bandwidth, noise effects, etc. The results of the benchmarking process are also shown in Table 1. The KKKL3171 course syllabus (Buku Panduan Prasiswazah UKM, Sesi Akademik in 2010/11) are compared to equivalent courses offered in foreign universities, New Jersey Science and Technology University (NJSTU), USA and Tohoku University, Japan. The benchmarking process indicates that the syllabus used in communication theory (Universiti Kebangsaan Malaysia) is almost similar with communication system course applied at Tohoku University at postgraduate level. In the Department of Electrical, Electronics and System, Faculty of Engineering and Environmental Built of Universiti Kebangsaan Malaysia, the benchmarking has been carried out on two levels, program and course stage. Researchers implementing the physically benchmarking on the program level while the virtual benchmarking is done at course level.

Here, every course offered by the department must have at least 2-3 benchmarking from the well established university to ensure the syllabus is up to date and fulfill the current technology demand. Additional, the department also has organized several meeting with industrial (at least once in semester) to look over the syllabus in all related courses to ensure the syllabus, skills and tools are fitted with what are required by the current industrial.

NJSTU gives emphasis on topics such as noise, random variables and their effects. The distribution of the

Table 1: Outcomes of benchmarking process between KKL3173 with equivalent courses offered in USA and Japan

[a]Communication theory (Bachelor program)	[b]Communication system (Bachelor program)	[c]Communication system (Master program)
Introduction to communication systems: block diagram, signal representative and noise	Introduction on communication systems	Communication system and noise
Analog Modulation (AM): AM, QAM, DSB, SSB	Brief review on signals, spectra and linear systems	Irregular signal
Analog modulation: VSB, modulator and demodulator, applications	Analog Communication Systems	Communication quality
Frequency Modulation (FM): Bessel function modulator and demodulator, applications	Brief review on noise and random variables	Error Control System
Phase Modulation (PM): modulator and demodulator, applications	Effect of random noise on the performance of communication systems	Transmission System 1
Digitization techniques: PCM, Delta modulation, ADPCM	Digital Data Communication Systems	Transmission System 2
Coding RZ, NRZ, AMI etc.	Probability of error and BER calculation and performance comparison	Switching System
Mid-semester examination	Spread spectrum and cellular systems	Digital Transmission System
Project communication system application	Multiplexing technologies (TDMA, FDMA, CDMA)	Multimedia Coding
Digital modulation: ASK, FSK		Multiple Access
Digital Modulation:PSK, BPSK, MSK, QAM		Information Network System
Digital multiplex: FDM, TDM, hierarchy		Distributed Processing System
Multiple access technique: CDMA. FDMA, WDMA		Distributed Intelligent Processing System
Communication system application, i.e., antenna, radar, FTTH, etc.		Next Generation Communication System 1
		Next Generation Communication System 2

[a]Universiti Kebangsaan Malaysia; [b]New Jersey Science and Technology University, USA; [c]Tohoku University, Japan

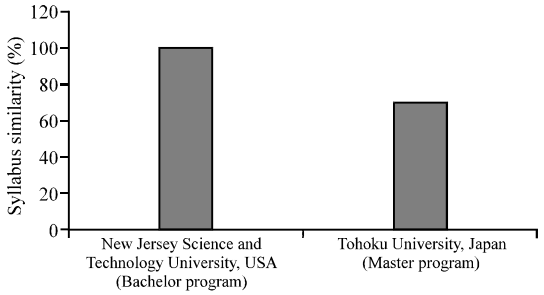

Fig. 1: The syllabus similarity between UKM and other universities (NJSTU) and Tohoku

subtopics is more general as compared to UKM where the subtopics are specific and reflect the taught syllabus. In general, it is concluded that the syllabus taught in UKM is equivalent with the syllabus applied in international universities.

Nevertheless, in practicing Continuous Quality Improvement (CQI) process, the department has stipulates that the courses syllabi must be reviewed, benchmarked and updated every year alongside with the technological growth and industrial needs. Figure 1 shows the similarity in UKM syllabus as compare to the course offered by NJSTU and Tohoku University. Here, 100% syllabus offered by NJSTU Bachelor Program similar to UKM and almost 70% syllabus offered by Tohoku in Master Program covered in UKM.

Exercising taxonomy bloom in drafting final examination questions: to achieve perfection: To beef up the quality of the final examination, the department applied bloom taxonomy in drafting the question sets according to the necessary taxonomy bloom. The department has introduced bloom taxonomy review form where the bloom levels are specified proportionately depending on different year of study (year 1-4). There are six levels of bloom, categorized into three groups: group 1 (level 1 and 2), group 2 (level 3 and 4) and group 3 (level 5 and 6). In this case, KKKL3173 course is dedicated for 3rd year students. Hence, the examination questions must consist of 0-20% of group 1, 0-40% of group 2 and 40-50% of group 3 and the drafted questions fit the students' proficiency. The bloom taxonomy review form could be obtained from the course teaching file.

MATERIALS AND METHODS

Quiz-students pre assessment: During early semester, the students were given a quiz to test their knowledge on communication technology topic and the course background. The quiz consumed of 5% from the overall course assessment.

Projects-ethics, professionalism and collected technical: Although, it is commonly recognized by educators and scholars alike that to be successful in today's workplace high levels of teamwork are necessary, most engineering programs provide little if any instruction in this area. Employers often report that new hires typically do not know how to communicate and that they have insufficient experience and preparation for working as part of a team.

Yet, little has been done to effectively address this issue. To be successful in today's workplace, engineering students must possess high levels of teamwork skills. Unfortunately, most engineering programs provide little or no specific instruction in this area (Lingard, 2010). Working with the Industrial Advisory Board for the department, a set of performance criteria for teamwork was developed.

This set of criteria was used to build an assessment instrument to measure the extent to which students are able to achieve the necessary skills. This set of criteria provides a clear basis for the development of an approach toward teaching teamwork skills. Furthermore, the results from the assessment can be used to adjust the teaching techniques to address the particular skills where students show some weaknesses. Although, this effort is in the early stages, the approach seems promising and will be improved over time. In this course, students were given 5 project titles which revolve around current technologies in communication system such as user access technology FTTH, ADSL, VHDL and data transmission protocol either Ethernet or ATM. Every group consists of 4-5 students where each of them has his/her own responsibilities:

- Group leader to lead the group
- Moderator to control and organize group presentation session
- Artistic to adorn the group research report
- Engineer 1 to gather information
- Engineer 2 to gather information

Project report must contain background, architecture, equipment, issues and current technology as well as comparison with equivalent technologies. Only one report is needed for each group and research was extensively done over the internet. The program objectives were measured from these reports while communication skills were evaluated during presentation session.

RESULTS AND DISCUSSION

Presentation-improving through open critic: Engineering criteria requires that engineering students learn and demonstrate an ability to communicate effectively, implying that they develop oral, written and graphical communication skills in an engineering context. The already overcrowded curriculum makes adding communications courses unacceptable. Also from a pedagogical point of view, teaching these skills as a part of a standard engineering course makes them more meaningful to the student than teaching them in stand-alone courses (Pimmel *et al*., 2002). In this course, the students were asked to do project presentations. Each group was given 15 min to present their outcomes. The evaluation was made by the main lecturer and invited lectures by using rubric form. After presentation, the evaluators gave comments on their virtues and flaws and how to improve their presentation skills through open critics. Five lecturers in the same field were invited for this purpose.

Technical-visit associating theory and practice: At least once in a semester, year 3 and 4 students are made compulsory to attend technical visits to industry. The students will have the opportunity to expose themselves to the real working environment and state of the art technologies available in industry through the technical visits. They are able to associate the subjects taught in the university which are theoretical basis with the industrial practices. In 2008/2009 session, the students went Radio Televisyen Malaysia (RTM) broadcasting station and TM RnD Optic Communication Network Unit. There were two lecturers who escorted them during these visits. Each student was asked to prepare a technical report focusing on the relation between what they have learned in class and practices in industry thus enriching their comprehension on the subject.

Technical seminar-industrial input: In every semester, various experts from industry are invited to give technical seminar to the students. As for case study, session 2008/2009 has presented a team from National Semiconductor Sdn Bhd to organize a seminar on electronic amplifier and noise compensation.

The seminar was materialized after a series of meetings between the department and the semiconductor company, National Semiconductor Sdn Bhd. The engineer from National Semiconductor explains on electronic devices design applied in telecommunication system.

Seminar on ethics and professionalism: Apart from technical seminar, the students are also exposed to talks on ethics and professionalism delivered by speakers from industry. Semester 1 Session 2008/2009 has invited Human Resource Manager of ON Sdn Bhd to give lecture on leadership.

The seminar was attended by students of year 3 and 4 of all programs of the department. The seminar entitled leadership. Its importance in industry was conveyed manager of human resource at ON Semiconductor Sdn. Bhd.

Industrial lecture-exposure on current technologies and issues: To establish students knowledge in this course, representatives from industries consist of technical staff are invited to give technical lectures. The purpose of these lectures is to get the students well informed on current technologies and issues in communication area. Session 2008/2009 has invited a Manager of Malaysia Telco to give lecture on fiber-to-the-home and once again the students were told to prepare a report.

Embedded laboratory to course: Integrated design and/or capstone design courses seem to present a number of challenges to both faculty and students. The need for the instructor to be able to evaluate student design work outside his/her area of expertise tends to make some faculty members uncomfortable teaching such courses. The lack of well defined problems and the open ended nature of engineering design coupled with their lack of practical experience, tends to frustrate many students in such courses (Kerkes, 1997).

The aim of this study is to expose students to the world of research in the field of green communication. The study will be highlighted the students to relate theory taught in lectures to practical research conducted in the laboratory. In this course, students will be exposed to the techniques of communication device fabrication by skillful hand. As shown in Fig. 2, two devices are fabricated are optical splitter and demultiplexer and both are used as components in the broadband communications by means of Wavelength Division Multiplexing (WDM). Installation of these devices in the POF-WDM network platform along with the application has also been demonstrated. Students are required to submit a report to report the learning acquired in the activity especially highlighted on the contemporary issue of green communication or environmental awareness.

The activity is assisted by one of department research laboratory and a few postgraduate students to give explanation on the project. Each student will have chance to fabricate themselves the devices.

Questionnaire/survey: The survey on program objectives is a method applied by the department to obtain feedback from the students about the weight and implication of each program objective incorporated in their courses.

Through a survey carried out for this course, the students recommended an integration of C++ or Matlab software to help them improve and understand better some of the elements in communication system such as bandwidth, channel space, sampling, convolution,

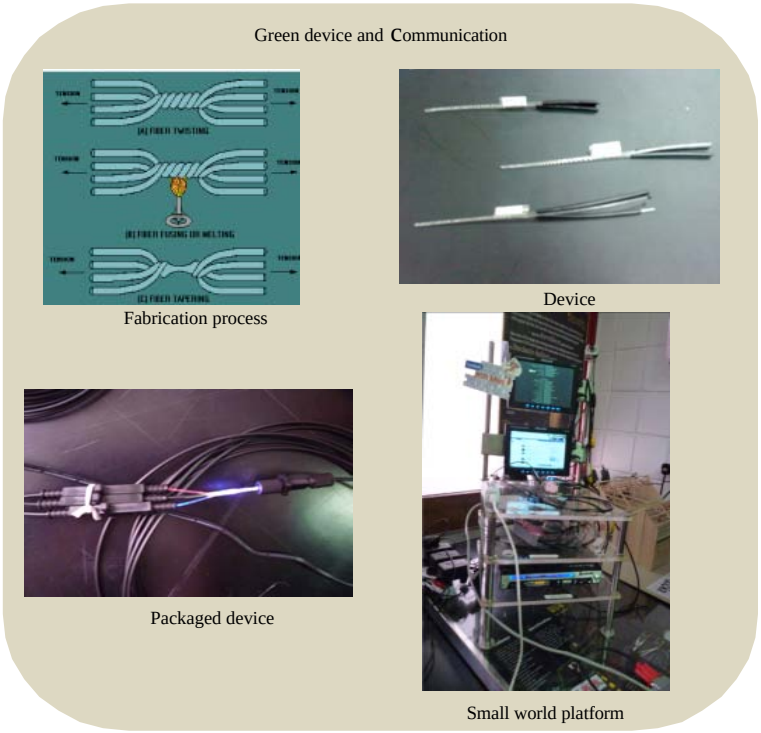

Fig. 2: The green communication solution will be demonstrated to the student which concern the environment is the best approach to attract the student to interest in their study. Green technology starts with the demonstration of environment of friendly fabrication and then installing the devices to green communication network

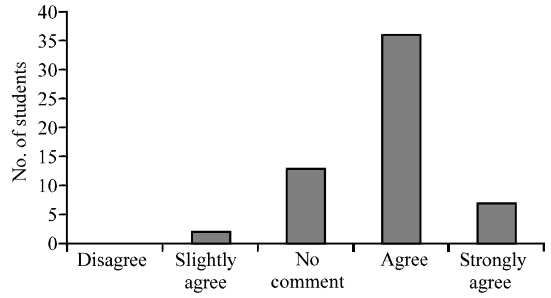

Fig. 3: Results from the questionnaire course improvement through the integration of software (C++ and Matlab)

transformation, signal differences in time and frequency domain, their importance, filter selection and others. In the questionnaire form, the evaluation score is fixed from 1 (Disagree) until 5 (Agree).

Of all 70 students taking this course, only 58 students responded. The survey results are shown in Fig. 3. In Fig. 3, 43 students agree that the integration of software in this course is necessary whereas 13 students are not taking any side. And 2 students feel that the application of software should not be implemented. Most probably, these students have no skills in handling the software and fear that their performance will deteriorate if the software were to be utilized.

However, the latter percentage is so small. Their concerns can be dealt with by the appointed lecturers who will teach this course in the next session. It was concluded then from this survey that the integration of software is necessary and will support students learning and understanding of this course. This study reports on the activities carried out for KKKL3173 Communication Theory as core course for the Department of Electrical, Electronics and System, Faculty of Engineering and Environmental Built, Universiti Kebangsaan Malaysia. The activities are designed in such a way that concerned parties from industry are involved throughout the curriculum taught to the students. A number of activities were carried out such as application of bloom taxonomy level in drafting the final examination questions, technical visits, ethics and professionalism seminar, industrial talks, students' presentation and open critics and embedded laboratory to course. A questionnaire/survey on how to improve the course was also carried out at the end of semester. Table 2 shows the activities covered to fulfill the EAC and MQF requirements in KKKL3173 Communication Theory, a core course of the department.

Table 2: Activities carry out and assessment tools to fulfill the EAC and MQF requirements in KKKL3173 Communication Theory, a core course of the department

Activities	Assessment tools
Lecture	Final, mid semester examination, quizzes, tutorial
Technical visit	Report
Ethics and professionalism seminar	Report
Industrial talks	Report
Students' presentation and open critics	Rubric
Embedded laboratory to course	Report

CONCLUSION

The study shows that Communication Theory course offered is on par with the equivalent courses offered by renowned universities such as New Jersey Science and Technology University and University of Tohoku, Japan. Several improvement activities which were suggested by external reviewers, IAP and industrial representatives have been carried out and cultured such as technical visit and seminar, motivation lectures, industrial talks and others. Course improvements are implemented by instilling appropriate and effective teaching elements such as open critic, formative assessment and generic assessment such as communication skills. Theory communication course is selected as it covers all students of our programs. Through the course evaluation activities assessment and program assessment activities, it can be concluded that this course has contributes towards the assessment as required by the EAC and KKM for Bachelor Degree in Engineering programs. The improvement activities were successfully carried out and continuous quality improvement has becomes a culture.

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