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# Curricula Management and ABET Alignment at the Lebanese International University School of Engineering

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**Abstract**

Since 2011, the School of Engineering (SoE) at the Lebanese International University has been actively engaged in the development and constant evolution of engineering programs that are aligned with an assessment protocol aimed at determining how well graduating students achieve intended learning outcomes of their respective programs. This is all done with the intention of having programs that are fully compatible with the Accreditation Board for Engineering and Technology (ABET) and in anticipation of future accreditation.

This paper highlights the curriculum management approach that has emerged from the collaboration between the various engineering departments, the development of program students' outcomes (PSOs) and their indices, and the results from the preliminary outcomes reporting that involves the collection of data in line with best practices, well established key performance indicators and standardized benchmarking in the engineering education community. All of which has been done as a part of education quality management and continual improvement purposes.

A novel approach was adopted dependent on students' evaluation of the PSOs. The evaluation process is used in a feedback loop to enhance the rankings of the PSOs. Preliminary Results indicate the usefulness of this technique. More data will be collected in the coming years to be able to establish statistical significance.

**Keywords:** Curricula management, ABET accreditation, PSO, KPI, benchmarking, academic assessment, reporting, engineering education.

## 1. Introduction

Since its establishment in 2000, the Lebanese International University (LIU) recognized the importance of students' learning outcomes and their impact on the quality of education. LIU's mission states: LIU endeavors to align its values and commitments to student learning, support, and communication and continually reviews curricula to introduce innovative outcomes (LIU, 2013). Learning outcomes are statements of what a learner is expected to know, understand and/or be able to demonstrate after completion of a process of learning (Donnelly and Fitzmaurice, 2005).

According to a report prepared by the World Bank in 2012, LIU is considered as the largest and fastest growing post war era private university in Lebanon. It has 13% of the overall number of students enrolled in private higher education institutes in Lebanon (WB, 2012). With such a rapid growth, there must be rapid changes introduced in order to align execution with strategy. Consequently, the university management decided to establish a task force to assess the situation and provide an action plan accordingly. This initiative was piloted in the School of Engineering (SoE). An action plan was put together by the task force in order to review courses syllabi and ensure that the learning outcomes are clearly stated according to best educational practices in this regard based on the Bologna process. Understanding that the success of such process depends on the comprehensive implementation of a learning outcomes approach in higher education (Rauhvargers, et al., 2009), the SoE piloted this project as of the Summer semester in 2012 and revised the syllabi of all courses offered at the school to align them with the Bologna process. Furthermore, it put together a plan to align with ABET guidelines in an attempt to seek accreditation in the future. ABET is recognized as the worldwide leader in assuring quality and stimulating innovation in applied science, computing, engineering, and engineering technology education (ABET, 2011).

When SoE started this exercise, it decided to follow a process where the outcomes are simple and clear, achievable, and assessable. In order to achieve that, the well-known Bloom's methodology was adopted. The list of direct unambiguous active verbs presented in Bloom's Taxonomy was strictly adhered to. In addition, the engineering programs were re-designed to comply with Bloom's six domains of knowledge arranged successively in a hierarchy as depicted in Figure 1:

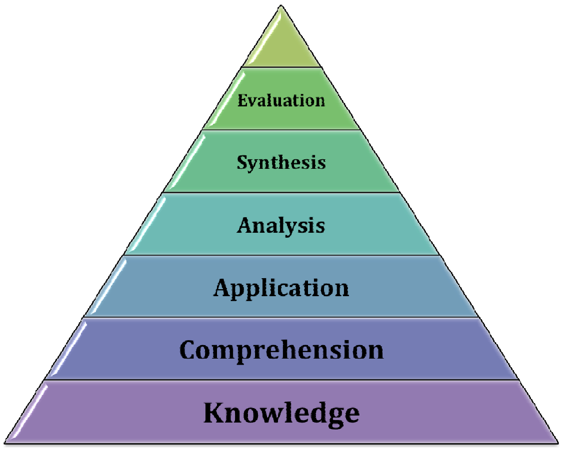



Figure 1. Knowledge domains hierarchy

Bloom's taxonomy is not simply a classification; it is an effort to arrange the various thinking processes in a hierarchy. In this hierarchy, each level depends on the student's ability to perform at the level or levels that are below it (Kennedy, et al., 2006). Furthermore, Bloom's research was centered on attitudes, feelings and values. This domain is concerned with issues relating to the emotional component of learning and ranges from basic willingness to receive information to the integration of beliefs, ideas and attitudes (Bloom, et al., 1964). This aligns well with the ABET's approach and methodology paving the way to full accreditation once fully implemented.

As this ABET alignment initiative was being implemented, the question of quality assurance (QA) came into play. It became evident that in order to sustain the program, evolve it, and improve it, some mechanism of quality assurance was needed. Again, the SoE was the ideal candidate to start implementing QA as it has the required set of competences and skills. A series of software tools were developed in-house in a joint effort between SoE instructors and senior project students. These tools included QA forms for assessment of activities related to the undertaken initiatives.

## 2. Strategy & Approach

The strategy of the School of Engineering was developed in-line with the university mission. It is compromised of multi-dimensions:

1) Learning: attract, retain and graduate students with skills suitable for local, regional, and international employability.
2) Faculty Sustainability: recruit, retain, and develop the skills and know-how of exceptional faculty members.
3) Community Service: Actively engage in community services and projects that serve the common good.

The strategic plan set forth for the school includes the goal of achieving accreditation from well-established and recognized international bodies. The main goal behind this strategy lies in the acknowledgement of the fact that most Lebanese graduates are recruited outside Lebanon. This global perspective was a major drive for the architecture of the curricula management plan leading eventually to accreditation.

Maintaining skilled faculty members is a common intrinsic part of both the accreditation goal and the school strategy. In its effort to balance between international as well as Lebanese accreditation requirements, SoE employed a fine-granular topic in the vertical decomposition of curricula and wide breadth horizontal multidiscipline coverage. This approach introduced many ostensible advantages, to name few:

1) The introduction of contemporary and "hot" topics early in the curricula (e.g.: Sustainable Energy, Mobile Applications, etc…).

2) Covering multidisciplinary subjects, which are intrinsic to real-life engineering professions.
3) Building student soft skills.

Curricula were built from the decompositions and assemblies of themes resulting from the approach described above. A major challenge introduced by the employed approach resulted from the fact that non-traditional assessment measures were needed when their counter-parts failed. In addition, all these atomic assessments must have a careful weighted impact on the overall program outcomes.

All of the above requirements were taken into the agile development of the curricula management process as well as the assessment tools. Agility was much important attribute of the design of these functions due to the "terra incognita" nature of the engaged elements.

The next two sections shed the light on the curricula management process as well as the assessment methodologies and tools developed in the quest to address the approach essentials.

## 3. Assessment Methodology & Tools

The SoE has been using a set of automated tools to continuously assess courses offered in all of its programs. The automation of the course assessment is based on two dynamic tools that were developed in-house by a joint effort between faculty and senior students. The tools are based on Microsoft Excel and provide the following functions:

1) Mapping of the course outcomes (CO) to the program student outcomes (PSO).
2) Creation of detailed grading activity sheets, which include exams, quizzes, projects, assignments, etc.
3) Mapping of each element (question, report, etc.) of the activity to the course outcomes.
4) Current letter grade of each student at any time of the semester.
5) Computation of each CO and PSO score.
6) Graphical and numerical statistical grade information
7) Mass class emailing capability.
8) Generation of an assessment report. The instructor uses this report to analyze the results and propose corrective actions.

A statistical tool that collects all class sections data and provides a statistical report including, among others, the overall average, median, mean, and percentile grades. It also generates an overall course assessment report containing the COs scores and the score of each program outcome. The coordinator uses this report to analyze the results, synthesizes the instructor recommendations, and proposes corrective actions to close the loop of continuous improvement. This tool can be used at any time of the semester to monitor, track and control the course performance for each activity.

## 4. Curricula Management Example

In order to illustrate the curricula management approach adopted at the SoE, it would be suitable to provide a concrete example involving one of the engineering programs. The curricula of the Computer and Communication Engineering (CCE) for both Bachelor's and Master's programs have undergone significant revisions in order to emphasize new trends in education and to introduce new technology.

A junior course on microcontrollers was designed and offered for the first time at the School of Engineering at LIU in 2011. This course aimed at providing students an opportunity to learn and practice fundamentals of CCE through hardware and software design, programming and interfacing to obtain a broad view of various subjects of CCE covering circuits, digital logic, microcontrollers and communications (Sztipanovits, 2005). The course outcomes, shown in figure 2, describe the expected ability of the student who successfully completes the course requirements. These outcomes were designed keeping in mind ABET's requirements and the contribution to the overall respective engineering program. Such a practice is standard among most of the engineering institutions around the world. At the end of each semester, students across all LIU campuses evaluate each course outcomes and results are compiled together making it possible to propose corrective action to improve course quality. The multi-campus common exams at the LIU require unified syllabus for each course making it possible to compile course assessments of all offered sections.

A student who successfully fulfills the course requirements will have demonstrated ability to:

CO-1. Describe the PIC18 microcontroller architecture
CO-2. Create software to communicate with the digital ports
CO-3. Design and develop iterative and decision based subroutines in assembly language
CO-4. Synthesize code that handle hardware and software interrupts
CO-5. Design and use timers in applications
CO-6. Interface external devices to the microcontroller

Figure 2. Course outcomes

The results of the students' assessment at the end of Spring 2013 are shown in figure 3 and 4. These results are used to propose corrective actions to improve course quality and to motivate students. The students' evaluation of the course outcomes was conducted over 114 students and the results show different level of satisfaction for each of the six course outcomes. The objective of the CCE department is to seek a degree of satisfaction (Strongly agree and agree) of 75% and above, and a degree of no satisfaction with less than 10%. It is clear from the results that outcomes 4 and 6 need an action plan and the results for those two outcomes are disappointing with 68% and 55%, respectively. The end of the semester meeting of this course was concluded by the following actions:

1) Increase the time allocated to problem solving related to the topics covered by CO-4 and CO-6.
2) Increase the in class demonstration of hardware interfacing using the course tools.
3) Add a project as course activity that focuses on hardware interfacing.

This is the first time such an assessment is applied for that specific course at LIU and the outcome of the corrective measures will be compared with future results in order to evaluate the proposed corrective actions and to gain steps in the continuous improvement at the CCE department.

Figure 3. Students assessment by numbers (Spring 2013)

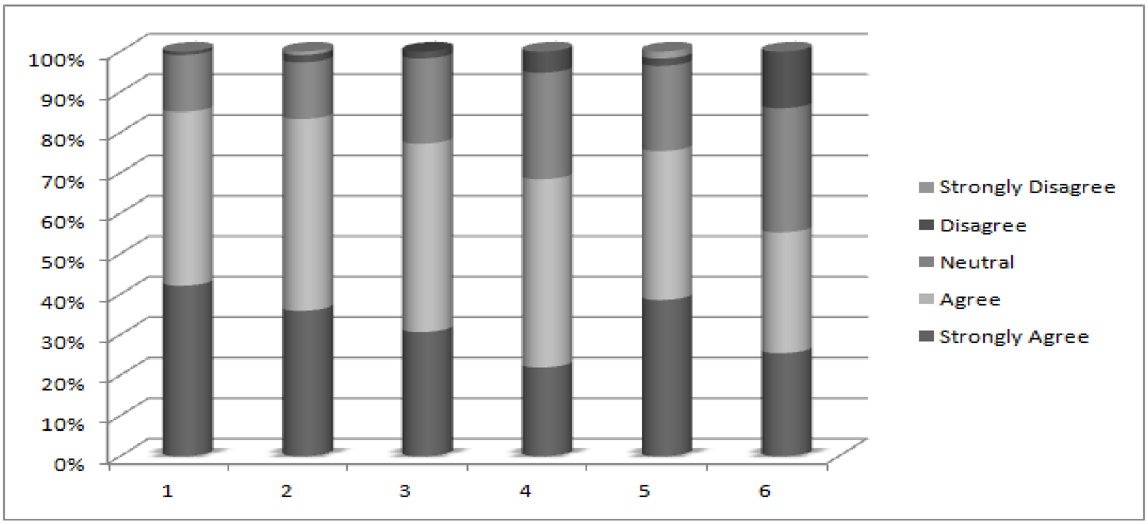
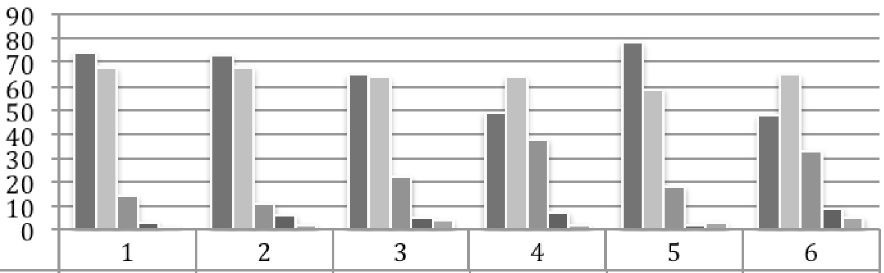



Figure 4. Students assessment by percentage of satisfaction (Spring 2013)

An important concept to keep in mind while designing and evolving curricula is the fact that they have to be designed to ensure that graduates possess all the qualities of a generalist and all the competences of a specialist, and are capable of life-long learning (Suliman, 2006). Based on this, the lab related to the Fundamentals of Digital Logic Design, a prerequisite to the Microcontroller course, in addition to the lab of the introduced course were redesigned at that time to answer the students' needs for better comprehension of the concepts taught in class and to gain hands-on hardware, software and design expertise. These modifications to the Computer and Communications Programs Curricula have made a significant impact on the senior projects quality and innovation. Hence, many senior students' projects are now related to microcontrollers, control boards and embedded systems. Students are now capable of selecting and implementing microcontroller based projects such as home automation, remote control vehicles, queuing systems, serial communication based modular control board and others.

The results of the students' assessment at the end of Spring 2014 are shown in figure 4 and 5. The students' evaluation of the course outcomes was conducted over 160 students and the results show different level of satisfaction for each of the six course outcomes. It is clear from the results that the evaluation of all outcomes is improved (for strongly agree and agree). Outcomes 4 and 6 have significantly improved from 68% and 55% to 71% for both outcomes. As the accepted threshold is 75%, the evaluation is short by 4% for both outcomes. The current results will be used to improve the quality of the teaching material to be able to reach the accepted levels.




| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Strongly Agree | 74 | 73 | 65 | 49 | 78 | 48 |
| Agree | 68 | 68 | 64 | 64 | 59 | 65 |
| Neutral | 14 | 11 | 22 | 38 | 18 | 33 |
| Disagree | 3 | 6 | 5 | 7 | 2 | 9 |
| Strongly Disagree | 1 | 2 | 4 | 2 | 3 | 5 |

Figure 4. Students assessment by numbers (Spring 2014)

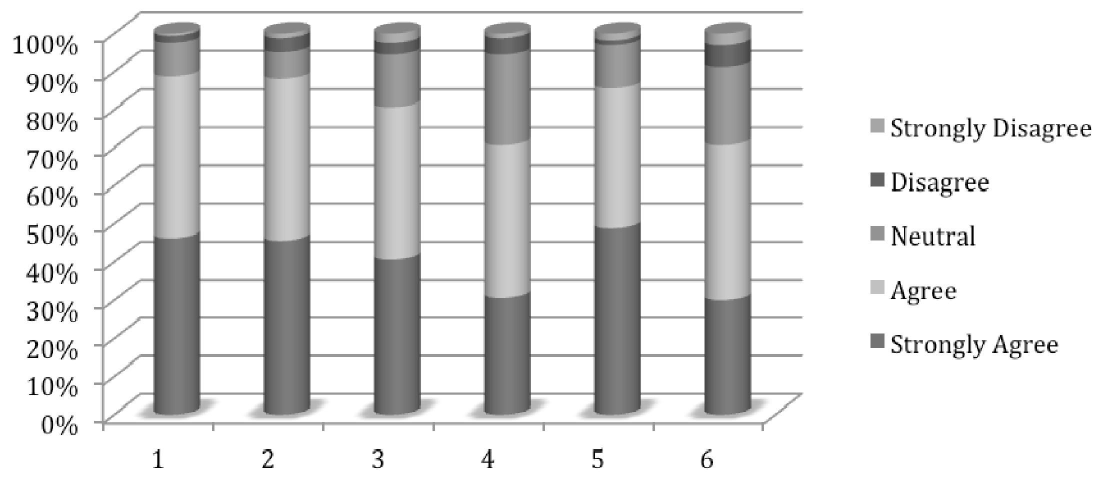



Figure 5. Students assessment by percentage of satisfaction (Spring 2014)

**5. Conclusion**

Since 2011, the LIU has been aggressively trying to enhance its engineering curricula. Curricula management has been largely controlled by a custom designed procedure, which involves database management with feedback from students and faculty. The procedure has been useful in providing quantitative feedback and independent enhancement evaluation. A general trend of favorable outcome evaluation has been established with increased enhancement effort. However, more data is needed to be collected in the future to establish statistical significance.

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