

Integrating Specialization-Specific area courses' Assessments for Overall Program Assessment

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Abstract

In developing countries, industrial environment is not diversified enough to allow graduating engineers to seek jobs in all specialization areas of an engineering discipline. Hence, it seems necessary to seek evolution of an engineering program assessment for specialized requirements of the industry. In literature, the specialization-specific courses' assessment has not been reported, at least to our knowledge. This paper describes how specialization-specific courses' assessments are integrated for effectiveness towards overall program assessment. A software program application is developed to automate this development to reduce assessment work and show equivalently as integration of specialization-specific assessments per outcome per term.

1. Introduction

The universities in different countries follow their own curriculum development philosophies and processes with the intention of producing "environment-ready" engineers. The ABET's requirement for accredited programs to implement outcomes-based assessment models has stimulated the growth of formalized assessment of programs within the engineering and engineering technology communities. In fact, a systematic process is to be in place to assess the achievement of both the program outcomes and the program educational objectives. This process needs to be ongoing to ensure the continuous improvement of each program with input from constituencies, process focus, and outcome and assessment linked to objectives [1-2]. The authors in [3] have described development of several innovative tools to automate the processes of assessment and evaluation of outcomes of college of engineering and individual ABET engineering programs. These tools depict quantitative information that is automatically plotted and users can view most recent results displayed relative to historical trends. The sustainable set of assessment tools have also been reported in [4] to measure achievement of stated objectives and outcomes related to ABET EC 2000 criterion. In [5], the authors have investigated the effectiveness of teaching by working out the automated system of monitoring the academic activities in order to control and diagnose actions necessary for goal oriented education process. The authors in [6] have developed custom designed assessment tools that are user-friendly to the lecturers/instructors using on-shelf technology to measure student's knowledge. The authors describe the utilization of the tools and evaluation for an undergraduate course. The Web has also been exploited [7] to develop outcome based assessment tool for skills practice and summative assessment. In [8], the authors describe in details innovative course outcomes' assessment tools used in an engineering Department. In that tool, a course outcomes' assessment program, developed in house, is used to evaluate the contributions of a given course, training, or any other item in the curriculum to the design, delivery and achievement of program outcomes. In summary, various methods and tools have been developed, tested and reported in literature for program assessment measurements, but specialization-specific area courses have not been investigated towards overall program assessment, at least in our knowledge.

In a typical scenario, the Department of Electrical Engineering (EE) at United Arab Emirates University (UAEU) has embraced the general philosophy of Outcome Based Education and has engaged in an assessment process where a set of tools have been utilized for direct and indirect measurement of program assessment components. In the next section, the program assessment process and its

components adopted at EE department of United Arab Emirates University are briefly described. The section 3 highlights an application to show how a course assessment is implemented. Section 4 provides implementation of an application developed for the purpose of computing assessment for a specialization track, for example computer area. In section 5, conclusions are presented, followed by references in section 6.

2. Program Assessment Process

Typically, the program assessment consists of two parts: annual report prepared by the assessment committee and the input from accreditation body from its previous visit. The annual report uses program stack holders' and external accreditation body feedback to generate program assessment, and is prepared using various tools and measurement results from current year and from at least previous two years. There exist typically two industrial advisory boards - one at departmental level, and the other at the college - to evaluate educational objectives, program outcomes, annual program assessment, and various assessment tools used.

The various tools (i.e., direct and indirect approaches) are usually used to assess the program outcomes. The set of tools include Curriculum quantitative assessment, Capstone course (Graduation Project), Exit exam, Exit interview, Internship survey, Alumni Survey, Employer survey, etc. In case of curriculum quantitative assessment, the Assessment Committee selects a set of courses (the most relevant for the targeted outcome) related to each program outcome to be assessed during that semester. Curriculum assessment is done collectively with the participation of all faculty members of the department. The curriculum assessment process involves three performance measures: Student assessment (S), Faculty assessment (F), and Quantitative assessment (Q). The qualitative data collected from the instructor and student assessment of course surveys on the outcomes of each course is analyzed and mapped to the corresponding program outcomes. Then the average of all courses is calculated to obtain the program outcome achievements.

Some of the program outcomes are best assessed qualitatively through capstone course, internship and extra curriculum activities. For example, the participation in the professional student branch, participation of students in extra curriculum activities (such as open day, activities day, workshops, field trips, seminars, etc) have direct impact on some of these outcomes. Like wise, internship is measured through an internship survey accumulated twice a year over a number of students before being included in program assessment. In an alumni survey an attempt is made to measure success by directly asking the alumni for their opinion of how well they are fulfilling the objectives. Similarly, in an employer survey the employers who employ our graduates, are directly asked for their opinion about skills of our graduates and how well our graduates are fulfilling the program objectives. As regards exit interview, this interview form is developed in order to poll the opinion of graduating students on the program outcomes and the way they feel the program has helped them acquire the skills and abilities.

An assessment report is planned each academic year for sake of evaluating the program outcomes and objectives. The report includes among others, the assessment results analysis, observations and recommendations. The evaluation of this report together with corresponding feedback based on program assessment results and effectiveness of the tools used drives the continuous improvement in assessment process. Additionally, a cyclic feedback to departmental curriculum committee ensures respective changes in program curriculum. The details of program assessment implementation at a typical university, for example UAE university, can be found in [9].

Let us look at program assessment in a different way. Previously, it was mentioned that in order to calculate program outcomes, averaging method is used across all courses outcomes. For example, if a particular outcome 'k' maps strongly to courses, say Circuits Lab, Power Lab, Control Lab, Logic Design Lab, Electronic Lab, Communications Lab, Microprocessors Lab, etc, then averaging of outcome 'k' of all these courses is computed to generate overall outcome 'k'. This gives overall view of outcome 'k' of EE program assessment. It does not tell, due to averaging however, how much contribution is made by courses that are related to, for example communications area, and like wise how much contribution is made by computer related courses. For this perspective, the courses may be grouped in baskets, each basket consisting of courses taken from specific area like science and

mathematics, circuits and electronics, computer, communications, power and control etc. This way, computer area for example, would contain core courses such as computer programming, digital logic design, microprocessors, computer architecture and electives such as embedded systems, java Programming, special topics in computer etc. Once outcomes are calculated per all baskets, then averaging across all baskets may be used to generate equivalently the overall program outcome values. For a particular outcome 'm', mathematically this can be viewed as:

$$Outcome_m = \frac{1}{N} \sum_{i=1}^N (\text{outcome}'m' \text{ of course } i) \quad (1)$$

$$Outcome_m = \frac{1}{L} \left[\frac{1}{M} \sum_{i=1}^M (\text{Outcome}'m' \text{ of course } i, \text{ basket } 1)_i + \dots + \frac{1}{M} \sum_{i=1}^M (\text{Outcome}'m' \text{ of course } i, \text{ basket } L-1) + \frac{1}{M} \sum_{i=1}^M (\text{Outcome}'m' \text{ of course } i, \text{ basket } L) \right] \quad (2)$$

where N , L , M represent total number of courses for the program, number of baskets created per program, and number of courses per basket respectively. For simplicity, it is assumed that number of courses per basket is same. The equation (2) is the focus of our program assessment implementation.

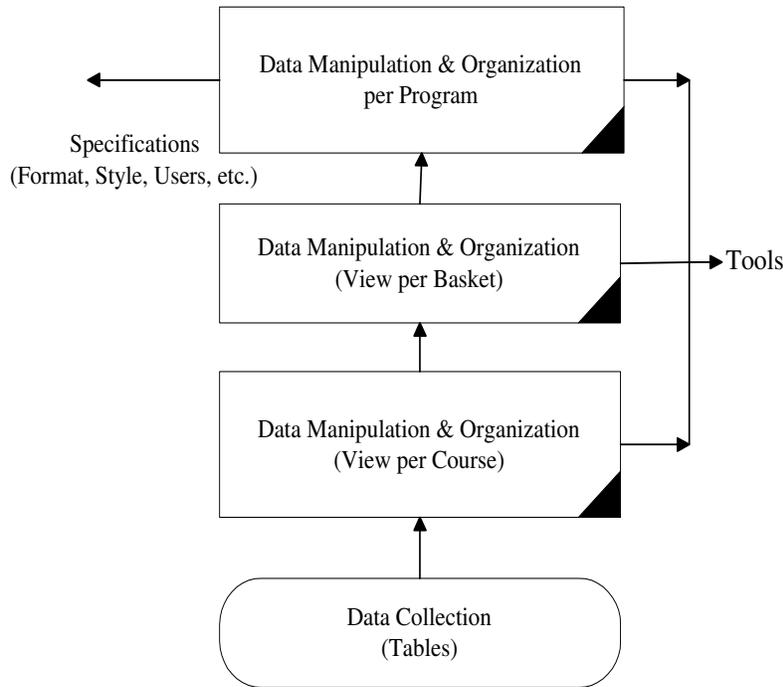


Figure 1: Data Flow Model for Program Assessment

As implied before, in addition to generating program assessment, this would help program curriculum analysts and industry experts to relate knowledge and skills learned by students in that specific area of the program to local industry requirements. As regards development of application tool in this case, assessment hierarchy in the form of data flow may look like as shown in Figure 1. The Figure 1 shows how assessment data and course tables are to be used at the lowest level to generate view of the course assessment. Later at the next level, different courses may be combined to generate cluster (basket) view of the courses, termed here as specialization area of the program. Finally, all baskets (including science, mathematics, etc) are to be combined to generate program assessment. In the next section, individual course assessment implementation is discussed followed by integration of various specialization-specific courses to generate assessment at the next (basket) level.

Course Coordinator:					# Credit hours:	3			
Course Name:	Microprocessor				POs to be assessed (<2):	E			
Course Code:	ELEC	Course No:	451		# Course Outcomes (<10):	8			

Fill in the COs mapping to POs with: 1 (Weak), 2 (Medium), 3 (Strong), or blank (None).

CO	A	B	C	D	E	F	G	H	I	J	K	0	0	0	0
CO-01					3										
CO-02					3										
CO-03					3										
CO-04					3										
CO-05					3										
CO-06					3										
CO-07					3										
CO-08					3										
CO-PO Relationship					100%										

CO	Description
CO-01	Identify the different units of microprocessor, and distinguish between different types of microprocessors. [E]
CO-02	Identify the internal architecture of 8088/8086 microprocessors, including the internal registers. [E]
CO-03	Differentiate between different instruction formats and addressing modes of the 8088/8086 microprocessors. [E]
CO-04	Familiar with the instruction set of the 8086/8088 microprocessor, including the data transfer, logic and arithmetic instructions, as well as the shift and rotate instructions. [E]
CO-05	Implement PUSH & POP operations in the stack, and conduct direct memory access. [E]
CO-06	Carry out appropriate procedure for subroutines operations in the microprocessor. [E]
CO-07	Familiar with the 8086/8088 hardware organization of the memory, their I/O and memory interfaces. [E]
CO-08	Familiar with the interrupt topics: interrupts, registers, and instructions etc. [E]

PO	Description
A	Ability to apply knowledge of mathematics, statistics, science and engineering principles. The mathematics knowledge includes linear algebra, vector algebra, partial differential equations, complex analysis, and probability and random processes
B	Ability to design and conduct experiments safely, as well as to analyze and interpret data
C	Ability to design electrical components, systems or processes to meet desired specifications with realistic constraints such as economic, environmental, social, political, ethical, health, safety, manufacturability, and sustainability
D	Ability to work in teams including multidisciplinary teams
E	Ability to identify, formulate and solve problems encountered in the practice of electrical engineering
F	Understanding of professional and ethical responsibility
G	Ability to communicate effectively orally and in writing
H	The ability to understand The impact of engineering solutions in a global, economic, environmental, and societal context
I	Recognition of the need for, and an ability to engage in life-long learning
J	Knowledge of contemporary issues
K	Ability to use the techniques, skills, and modern engineering tools necessary for electrical engineering practice

Course Activities (Remaining %) = 0.00% Number of Activities = 10

Activity #	Description	Weight %	Activity #	Description	Weight %
Activity 01	Hwk1	3%	Activity 06	Exam1	10%
Activity 02	Hwk2	3%	Activity 07	Exam2	10%
Activity 03	Hwk3	3%	Activity 08	Exam3	10%
Activity 04	Hwk4	3%	Activity 09	Midterm	25%
Activity 05	Hwk5	3%	Activity 10	Final Exam	30%

Figure 2: Settings Sheet for Course Assessment

3. Course Assessment Implementation

In this section, a course assessment implementation is described that follows the procedure described in the previous section. This implementation eases assessment process, provides more accurate and clearer feedback that helps improve the course delivery in the subsequent semesters, and forms the basis for upper levels in the program assessment process. For sake of simplicity, an excel workbook is chosen to contain all implementation steps and details that a course assessment may require. The excel workbook contains a number of excel sheets: a *settings* sheet that contains information about the course, credit hours, number of course outcomes and their description, number of program outcomes it assesses and their description, number of quantitative assessment activities in the course along with their description and weight; *activity* sheet for each quantitative assessment activity like homework, quiz, test, exam, project, etc; *qualitative student 'S' assessment* sheet that records input from each student and calculates average of each course outcome and maps to program outcomes being assessed in the course; *qualitative instructor 'I' assessment* sheet that records opinion of the instructor for each course outcome and calculates average of each course outcome and maps them to program outcomes being assessed in the course; *calculation sheet* that calculates quantitative score of each student per course outcome in each activity; *student assessment summary* sheet that shows summary of values for each course outcome and program outcome assessed in the course; a *dashboard* sheet that calculates and shows score and grade earned by each student taking the course; final *course assessment* sheet that retains last two years assessment scores along with comments and fills current final assessment scores 'Q', 'S', 'I' from various sheets just described. For illustration purposes, *settings* sheet is shown in Figure 2.

All of these course assessment steps are fully automated except when modifications are needed to the course assessment, for example changes in course outcomes and corresponding program outcomes, change in number of assessment activities for the course, etc. In summary, for a normal course without any changes, only student information and assessment activities are to be recorded in *dashboard* and *activity* sheets, all other sheets remain unchanged.

Table 1: Computer Area (basket) Courses mapped to Program Outcomes

Outcome	Courses						
<i>a</i>	ELEC330	ELEC335	ELEC570				
<i>b</i>	ELEC345	ELEC570					
<i>c</i>	ELEC345	ELEC335	ELEC462	ELEC561	ELEC562	ELEC570	
<i>e</i>	ELEC330	ELEC335	ELEC451	ELEC561	ELEC570		
<i>j</i>	ELEC462	ELEC562					
<i>k</i>	ELEC330	ELEC345	ELEC461	ELEC462	ELEC561	ELEC562	ELEC570

The final *course assessment* sheet, however, would always require comments to be recorded based on current course assessment and suggestions from last offering of the course. For illustration purposes, *course assessment* report sheet is shown in Figure 3. At the completion of individual course assessment, the equation 2 is partially implemented as each course belongs to one area (basket) only and contributes to a few course outcomes. The work still remaining is averaging across area (basket) course assessments, followed by averaging over areas (baskets).

4. Integrating Courses' Assessments

In this section, grouping and integration of individual course assessments are discussed. As one course assessment is implemented using excel workbook program, all course assessments follow the same assessment style and format, and they need to be kept in the same folder as well since all individual course outcome results are to be read automatically from each excel workbook. These values are then averaged and placed in the area-specific (computer basket, example) excel workbook.

At EE department of United Arab Emirates University, area (basket) courses for each outcome (a-k) are grouped based on respective (higher weighted) targeted outcome. The primary objective of this grouping is to remove unnecessary calculations due to insignificant impact of majority of the courses for a particular course outcome, since each course may not target all program outcomes with the same weight. This simplifies the calculations without much difference and helps in reducing the course assessment load on each faculty and the assessment committee. For computer area (basket), this is illustrated as follows.

Department of Electrical Engineering		Course Assessment Report: Outcome *** E ***				Date (DD-MMM-YY):		12-Jan-2010			
UAE University		(Edit pink boxes only)				Semester:		Spring 2010			
Course Name		Microprocessors									
Course Code & Number		ELEC451		# Credit Hours		3	Number of Students		17		
POs to be Assessed		E				0					
Faculty											
Instructor(s)/TAs											
Assessment Techniques	Used	Assessment Techniques	Used	Assessment Techniques	Used	Assessment Techniques	Used	Assessment Techniques	Used		
Quizzes	N	Midterm	Y	Labs	N	Class Participation	N				
Homeworks	Y	Final	Y	Written Reports	N	Instructor Observ.	N				
Progress Exams	Y	Projects	N	Oral Reports	N	Other	N				
ASSESSMENT RESULTS: OUTCOME *** E ***											
PO	Description	SCORES									
E	Ability to identify, formulate and solve problems encountered in the practice of electrical engineering.	Current Semester		Previous offering		2nd Prev. Offering		3rd Prev. Offering			
		Semester	Spring 2010	Fall 2009	Fall 2008						
		Student	2.66	4.2	3.5						
		Instructor	3.0	4.0	4.0						
		Quantitative	5.0	4.0	4.0						
		1. Result of Previous Offering Corrective Actions: Outcome *** E *** (Max. 1000 Char.)							# Charac.=154		
		The course had only one section for boys, so no coordination issue due to multiple sections (boys and girls) involving different instructors, was noticed.									
		2. Current Semestre Assessment: Outcome *** E *** (Max. 1000 Char.)							# Charac.=185		
		The course was delivered according to scheduled timelines versus contents. In summary, it was conducted in well manner. The student response and quantitative assessment were very good.									
		3. Suggested Corrective Action for Next Offering: Outcome *** E *** (Max. 1000 Char.)							# Charac.=87		
Continue the same strategy of home works, in class tests, a midterm, and a final exam.											
4. Continuous Improvement Analysis: Outcome *** E *** (Max. 1000 Char.)							# Charac.=0				
5. Focus Group Suggestions and Comments: Outcome *** E *** (Max. 1000 Char.)							# Charac.=0				

Figure 3: Course Assessment Report Sheet

The Computer area (basket) includes courses such as: Computer Programming (ELEC 330); Digital Logic Design (ELEC 335); Digital Logic Design Lab (ELEC 345); Microprocessors (ELEC 451); Microprocessors Lab (ELEC 461); Computer Architecture and Organization (ELEC 462); Embedded Systems (ELEC 562); Java Programming Techniques and Applications (ELEC 561); Special Topics in Computer (ELEC 570), etc. For all these courses, grouping per program outcomes is shown in Table 1. The Table 1 shows those courses that map strongly (in weightage) against each outcome. The Table 1 also shows that computer area (basket) courses do not contribute towards program outcomes d, f, g, h, and i. This mapping requires that for outcome a, the computer area (basket) excel workbook

shall read from ELEC 330, ELEC 335 and ELEC 570 workbooks. For this purpose, separate visual basic macros were written and framed as application buttons on computer area (basket) excel workbook. The visual basic was chosen as it is simple to implement and works well with Microsoft Excel program [10].

Sub Button'j'_Click()
' reading first file
Dim xl As New Excel.Application
Dim xlw As Excel.Workbook
' Open the excel file.
Set xlw = xl.Workbooks.Open("C:\Users\ELEC462.xlsx")
xlw.Sheets("ELEC462").Select
' Get the value from cell(2,3) of the sheet.
' MsgBox xlw.Application.Cells(3, 2).Value
Range("C6").Value = xlw.Application.Cells(19, 9).Value
Range("D6").Value = xlw.Application.Cells(20, 9).Value
Range("E6").Value = xlw.Application.Cells(21, 9).Value
Range("F6").Value = xlw.Application.Cells(25, 7).Value
' Close worksheet without save changes.
' If you want to save changes, replace False below with True
xlw.Close False
' free memory
Set xlw = Nothing
Set xl = Nothing
'reading 2nd file
Dim xl2 As New Excel.Application
Dim xlw2 As Excel.Workbook
' Open the excel file.
Set xlw2 = xl.Workbooks.Open("C:\Users\ELEC562.xlsx")
xlw2.Sheets("ELEC562").Select
' Get the value from cell(2,3) of the sheet.
' MsgBox xlw.Application.Cells(3, 2).Value
Range("C7").Value = xlw2.Application.Cells(19, 9).Value
Range("D7").Value = xlw2.Application.Cells(20, 9).Value
Range("E7").Value = xlw2.Application.Cells(21, 9).Value
Range("F7").Value = xlw2.Application.Cells(25, 7).Value
' Close worksheet without save changes.
' If you want to save changes, replace False below with True
xlw2.Close False
' free memory
Set xlw2 = Nothing
Set xl2 = Nothing
End Sub
Figure 4: A sample Visual basic Code for Outcome 'j' button

The buttons read required values and comments from specific rows and columns of each concerned excel workbook for each outcome, average outcome values and place the results and comments within specified fields in outcome-specific excel sheets of computer area (basket) workbook. A sample code of visual basic macro for outcome 'j' button is shown in Figure 4. It can be seen from Figure 4,

that area to be read from each course excel workbook is same. This allows for uniformity and code reuse. Similarly, for other outcomes, buttons are to be created and placed within computer area (basket) excel workbook. Once required course excel workbook files are placed in the same directory, the buttons when executed perform the required function for computer area (basket) assessment. This completes the automation of assessment at area (basket) level, and ready for integration at next level of grouping. In terms of equation 2, this equals completion of one averaging term within brackets. In order to complete all averaging terms within brackets in equation 2, same procedure is repeated at the next level. The program assessment combines assessments from each area (basket) in the similar fashion since each area (basket) assessment is in the form of an excel workbook.

5. Conclusions

The main tool used is Microsoft Excel as it is popular with instructors for being simple and easy to re-use and flexible with simple-to-make changes. The tool produces a set of reports that indicate how well students performed for each course outcome (in *course assessment report* sheet) and what is the impact of the course on the area (basket) level (in *group assessment* report) and finally at program outcomes, in general.

The main problem faced is time consumed in opening excel workbook as each one consists of a number of excel spreadsheets within it. This difficulty is affordable at course assessment level. At area (basket) assessment level, the tool opens various course assessment files one by one for reading required data, copies text and required data, closes the files one by one, does averaging and places them at required places in another excel workbook, then closes the output file. The time consuming problem is in fact inherent in Microsoft Excel as database and calculation is embedded in one tool. Alternatively, a database may be selected like Microsoft Access or Oracle to store all required data in the form of tables that are to be needed as raw data for course, area-specific and program assessment levels. Next, engines like Java and Visual Basic may be selected to read, calculate and present the data in the required format.

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