

An Effective Model for Course-level Continuous Improvement in an Electrical Engineering Technology Electronic Communications Course

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Abstract – In this paper, we describe an effective model for course-level continuous improvement through incorporating computer simulations and other performance-based assignments for theory development and conceptual design in an undergraduate electrical engineering technology course in electronic communications. Several experiments used to reinforce student learning of communications theory and applications, including assignments on amplitude modulation, frequency modulation, demodulation, and power spectrum analyses were developed and pilot tested during the 2006-2007 academic year. A major goal of this work was to document the process used for course reorganization, in particular, transitioning from a circuits-based approach to a systems-based approach for presenting concepts. In addition to course reorganization, we developed assessment tools that measure student performance and provided a mechanism for evaluating student learning relative to instructional effectiveness. Based on the preliminary results from the 2006-2007 academic year, our model for course-level continuous improvement is very effective for student comprehension of concepts and learning skills for this course.

Keywords: electronic communications, continuous improvement, Electrical Engineering Technology

INTRODUCTION

Continuous improvement is an important issue for Engineering Technology programs because it defines the framework for assessment and evaluation, which is required by accrediting agencies. Consequently, an accredited program that accomplishes its mission and successfully achieves its program objectives and outcomes must have multiple levels of continuous improvement whose results are used to constantly update and evaluate the program for sustained improvement and continued success. A plan must exist that details program-level continuous improvement, as well as course-level continuous improvement. Figure 1 illustrates the relationship between the course-level continuous improvement and the program-level continuous improvement process. The plan is used in the Electrical Engineering Technology (EET) program in our department, the Department of Mechanical and Electrical Engineering Technology (METEET) program. The *Program Assessment and Evaluation Plan* is a five-step process that includes program assessment planning, data collection, data analysis, program review and program improvement actions. During this step, the program objectives and outcomes are evaluated and revised, if necessary, to maintain currency and technical relevance of the program. Using the results from this plan, a curriculum mapping worksheet (CMW) is modified and used to revise the course-level assessment and evaluation plan. The CMW is a matrix mapping each course in the EET curriculum to appropriate program outcomes and identifies assessment tools used to measure the success of each outcome.

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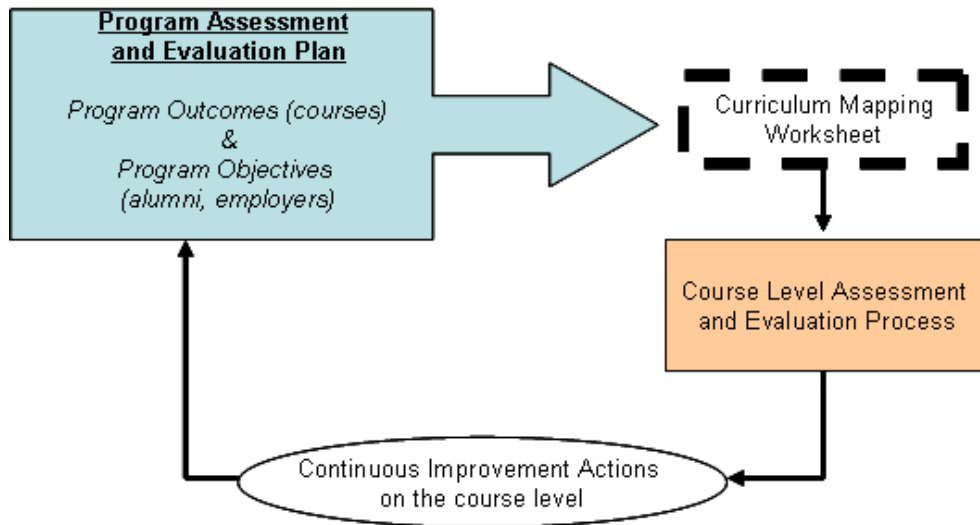


Figure 1-METEET Program Assessment and Evaluation Plan

Moreover, the CMW provides a mechanism for correlating program-level outcomes with course-level outcomes using effective assessment tools to measure student performance. Based on the results of the assessment tools, continuous improvement actions at the course level and program level are identified and used to revise the program assessment and evaluation plan. The actions are implemented during the next cycle of assessment.

In this paper, we describe course-level continuous improvement for one of our undergraduate courses in electronic communications. We focus on three main issues: *course reorganization*, which includes a discussion on why there was a need for course redesign and how it affects student performance, *development of assessment tools*, which describes the mechanisms used for course-level assessment, and the *implementation of the continuous improvement plan*, which describes the results of the continuous improvement process during the pilot academic year 2006-2007.

COURSE REORGANIZATION

We redesigned the course from a circuits-based approach [Young, 3] to a systems-based approach for presenting communications concepts. There were two main reasons for this transition. First, the course was initially offered as an elective course for students interested in communications systems. However, electronic and power were the two main curricular tracks taken by students. To accommodate these students, a circuits-based instructional approach was used. After careful re-examination of the course, we observed low enrollment numbers and average student comprehension. We recognized that by re-designing the course using a systems approach we could incorporate more applications and develop student learning. Thus, more students would be able to benefit from this approach.

The subject matter in electronic communications includes concepts like spectral analysis, frequency representation, power spectrum, etc. These concepts are crucial to the knowledge base of every electrical engineering technology student not just those who *electd* to take the course. As a result of this observation, the course became a core requirement for our students, which constituted a course re-design, hence, the second reason. By making this course a requirement in our program, it was necessary to choose a news textbook [Stanley, 2] and to develop assessment tools that could be used to effectively evaluate student learning.

DEVELOPMENT OF ASSESSMENT TOOLS

For our course-level continuous improvement plan, we developed assessment tools that were both *direct* measures (measurement tools that directly correlate to student performance) and *indirect* measures (measurement tools that provide additional information about student performance) [Bollag, 1]. Feedback from both types of measures allows for better identification of learning and teaching challenges, which could help develop more effective

strategies for course improvement. We also intentionally incorporated mechanisms to evaluate instructional strategies of poorly grasped concepts so that instruction of the course content is continuously improving as well. There are three assessment tools that are used by instructors to assess and evaluate their courses: a *course-level outcomes* form, a *continuous improvement efforts* form, and *student course outcomes evaluations* form.

The Course-level Outcomes (CLO) form is completed by the instructor and submitted to the assessment committee at the end of each semester. This form states each course outcome relative to program outcomes; identifies the assessment tools that are being used to measure the student performance of each outcome and the corresponding rubric analysis result for each assessment tool. The CLO form also indicates whether the benchmark has been met or not. An example of a CLO form is given in Figure 2.

	Course Learning Objectives <i>At the end of this course students will be able to:</i>	Course Outcomes/ Evaluation Measured <i>Throughout this course students will be able to:</i>	Corresponding Program Outcomes (a-k)	Assessment Instrument/ Evaluation Measure	Actual Level (4 pt scale)	Action(s)/ Recommendation(s) for Instructional Objective Improvement
1	Define basic communication system vocabulary including basic concepts and principles	- define basic communication concepts (bandwidth, modulation/demodulation, decibel notation)	a, b, f	Rubric of Exam 1	2.68/4.0	No action required
2	Determine the spectrum of periodic and non-periodic signals	- determine signal spectra of electrical signals	a, b, f	Rubric of Exam 2	3.04/4.0	No action required
		- implement common communications filters	a, b, f	Rubric of Lab 2	2.67/4.0	No action required
3	Analyze communication systems in terms of frequency response, filter implementation, oscillator circuits and receivers	- describe a phase locked loop circuit and its application to frequency synthesizers	a, b, f	Rubric of Exam 3 Problem A.6	3.20/4.0	No action required
		- analyze mixer circuits using frequency conversion principles	a, b, f	Rubric of Exam 3 Problem B.2	3.09/4.0	No action required
		- identify properties of receiver circuits	a, b, f	Rubric of Exam 3 Problem A.11	3.56/4.0	No action required
4	Analyze systems using common modulation techniques including Amplitude Modulation and angle modulation (FM and PM)	- describe amplitude modulation methods including SSB and DSB	a, b, f	Rubric of Final Exam Problem 1	3.36/4.0	No action required
		- analyze amplitude detection systems	a, b, f	Rubric of Lab 6-AM Analysis	3.8/4.0	No action required
		- describe characteristics of frequency modulation	a, b, f	Rubric of Final Exam Problem 3	3.22/4.0	No action required
		- analyze frequency modulation detection circuits	a, b, f	Rubric of Lab 6-FM Detection	2.11/4.0	Devote more lecture time to frequency detection circuits; give more assignments emphasizing FM modulation and detection
5	Simulate, test and verify communications systems using lab equipment	- Submit neat and professional lab reports	i, c, e, g, k	Lab Average	2.93/4.0	No action required

Figure 2-Example of Course-level Outcomes (CLO) Form

The Continuous improvement Efforts (CIE) form tracks continuous improvements actions that have been identified based on CLO results. The instructor completes and submits a CIE form for each outcome measure that falls below the benchmark. On the CIE form, the instructor must identify the outcome that was triggered, the assessment tool that was used to measure the outcome, the corrective plan of action to eliminate the problem, and the results of implementing the action plan.

The student-course-outcome (SCO) evaluations form is an indirect measure. It is used to collect feedback from the student constituency base on their perception of achieving the defined course outcomes. A rubric analysis is performed and if a particular outcome falls below the benchmark, a review is initiated.

Figure 3 illustrates the entire course-level continuous improvement process. During course offering A, an assessment report, which consists of the three assessment forms (CLO, CIE, and SCO), are completed and submitted to the program assessment team by the course instructor. The forms are reviewed and made available to other instructors for further analysis and review. The instructor for course offering B will use the results to develop instructional methods to address student needs cited in the assessment report from instructor A. At the end of the course offering B, the course instructor will submit an assessment report for analysis and review. The cycle

continues providing feedback on student learning and instruction for continuous course improvement. This process was used during the 2006-2007 academic year for course-level continuous improvement for an undergraduate electronic communications course in the EET curriculum. The results are described in the next section.

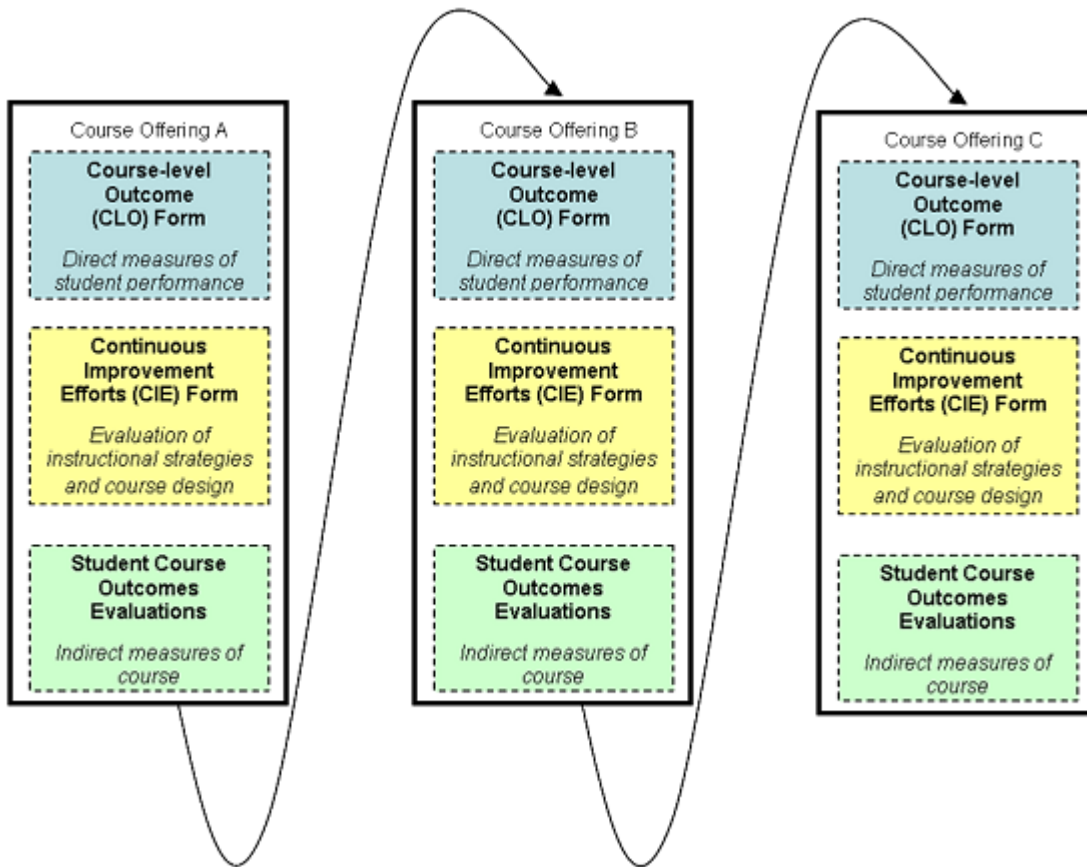


Figure 3-Flow Diagram of Course-level Assessment & Evaluation Process

IMPLEMENTATION OF CONTINUOUS IMPROVEMENT PROCESS

The course-level continuous improvement process was pilot tested during the 2006-2007 academic year. The undergraduate electronics communications course was offered during the fall semester 2006 and the spring semester 2007 so a complete cycle of assessment could be performed. The assessment forms that were submitted from the fall semester course offering revealed that some students did not grasp the main concepts related to frequency domain representation of periodically gated signals. The assessment tool used to measure this shortcoming outcome was the final examination. An instructional plan of action for improvement was devised, which included more lectures that emphasize these concepts in greater detail and the incorporation of more visual content to help students visualize frequency and spectral analysis concepts.

As a result of the fall semester assessment report, the spring semester instructor was able to develop instructional methods that incorporated the plan of action developed in the fall report. The following goals were achieved during the spring semester 2007:

- The lecture time devoted to Fourier analysis increased by 25%. Lecture notes were also made available to students for further study.
- More assessment activities on Fourier analysis and spectrum were incorporated into the course. Students were assessed on their theoretical competencies in this area using a homework assignment and an

examination. Students were also assessed on their practical understanding using two laboratory experiments on spectral analysis.

The CLO form from the spring semester showed that with the incorporation of the instructional strategies outlined, the majority of students grasped the main concepts related to Fourier theory and spectral analysis. The outcomes related to Fourier analysis, frequency-domain representation and spectral content were not triggered during the spring assessment cycle. Thus, the implementation of the plan of action devised from the fall 2006 semester proved to be successful in achieving the stated goals and providing continuous improvement that was advantageous to both effective instruction and student comprehension.

FUTURE WORK

The course-level continuous improvement process was shown to be very effective in targeting problems in conceptual student learning during the 2006-2007 academic year. However, there are several improvements that can be made to improve the overall efficiency of the process. For example, a real-time implementation of the plan of action described on the CIE form should be incorporated to benefit current students struggling with conceptual understanding. The course-level continuous improvement process is good for improving instructional strategies and increasing student comprehension, however it increases the workload for instructors. Consequently, autonomous means for collecting and submitting data would be very useful for instructional efficiency. Future work will explore the incorporation of these options to increase the effectiveness of the process and provide a more streamlined approach to course-level, and ultimately, program-level continuous improvement.

CONCLUSION

An effective model for course-level continuous improvement plan in an undergraduate electrical engineering technology program was presented in this paper. Several experiments used to reinforce student learning of communications theory were developed and pilot tested during the 2006-2007 academic year. Assessment results proved to be successful in achieving the stated goals and providing continuous improvement for student comprehension albeit at increased instructor workload. Future work will explore the development of autonomous means to streamline the collection of data and submission process.

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