Implementing Change: A Model for Closing the Continuous Improvement Loop the First Time and Every Time

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Abstract

This paper will highlight the process the Department of Agricultural and Biological Engineering (ABE) is using to implement change and prepare for long-term assessment of its programs. Emphasis will be placed on continuous education of and open communication with the faculty, data collection, analysis, and interpretation, and assessment plan/process improvement.

II. Assessment Process

After two years of faculty and staff education, assessment process development, and data collection, the Department of Agricultural and Biological Engineering (ABE) at Purdue University is closing the loop on their first round of assessment for their two ABET accredited programs: Agricultural and Biological Engineering (ABE) and Food Process Engineering (FPE). Figure 1 delineates the assessment process being adopted by the Department of Agricultural and Biological Engineering (ABE) at Purdue University. The two looped educational assessment process mirrors the two loops of EC2000 [1]. In the outer 3-5 year loop, the process allows constituents to provide input to and feedback on each ABE program. The faculty integrates this information into the ABE mission and vision statements, educational objectives, program outcomes (PO), performance criteria (PC), and, ultimately, the curriculum. The inner loop of the process focuses on course level evaluations and analysis of student and graduate performance followed by an assessment of gaps between the expected and actual student achievement levels. The loop is closed with a mechanism for instituting change to improve the program.

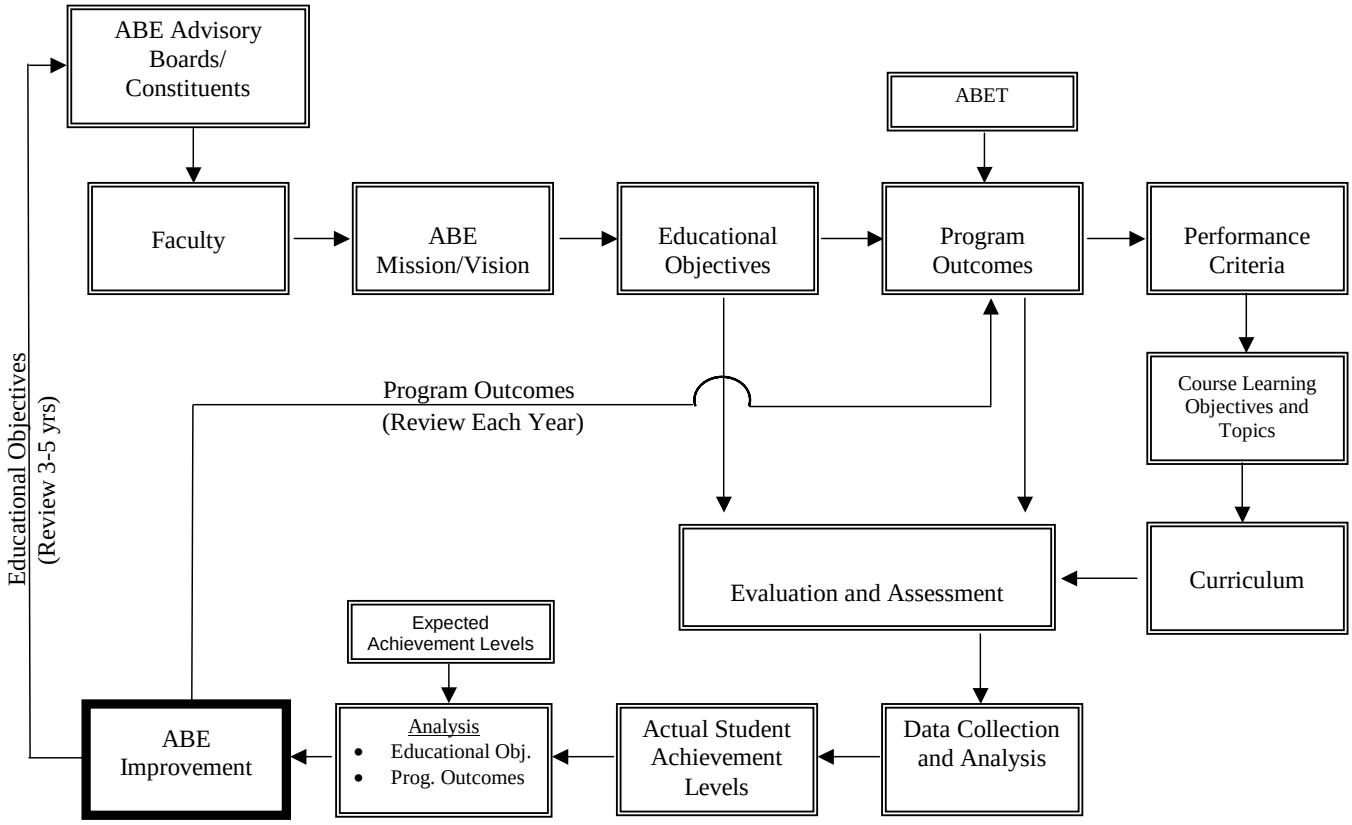

Figure 1. ABE & FPE Educational Assessment Process (*draft*)

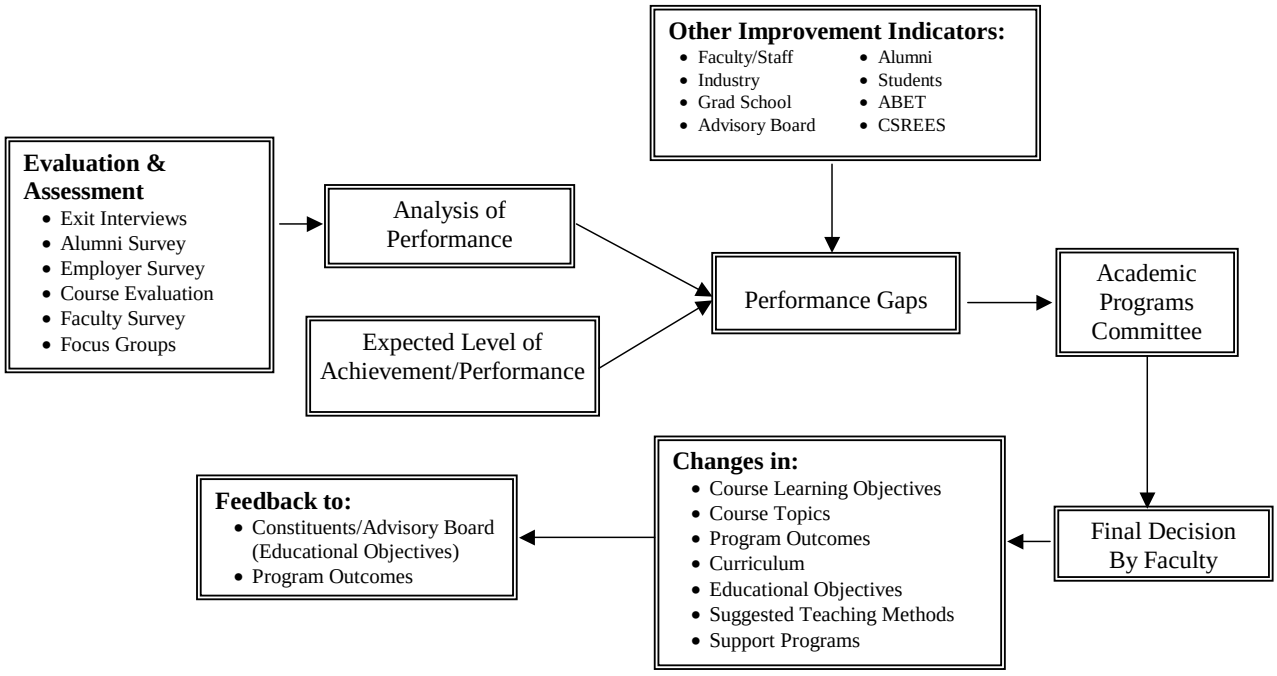

Figure 2. ABE & FPE Improvement Process (*draft*)

Figure 2 details the ABE improvement process. ABE is employing a mechanism wherein the Academic Programs Committee (APC), comprised of ABE faculty members, staff, and student representatives, gathers and analyzes data according to the assessment plan. Using standards established by APC and supported by the faculty, APC highlights potential areas of the programs that need improvement and proposes options for improvement. All proposals are brought before the faculty for discussion. The department head ultimately directs the implementation of change.

III. Faculty Involvement

The message "involve the faculty in the assessment process early and often" heard at professional conferences whenever the discussion of turns toward preparation for EC 2000 was taken to heart by APC. While APC has lead the development and implementation of the department assessment plan, the ABE faculty has undergone training concerning the assessment process, been asked for input to the process, and been kept apprised of implementation progress since the very beginning. Table 1 is a timeline of interactions between APC and the faculty over the initial two-year planning and implementation period.

Table 1. Timeline of Interactions with Faculty for Training and Education on Program Assessment

Date	Gathering	Topic
Dec 10, 1998	APC Meeting	APC was charged to coordinate and lead departmental ABET efforts for 2001 review.
Feb 12, 1999	Faculty Meeting	APC informed faculty regarding new ABET Criteria and changes to prepare for EC 2000 and the ABET Review. This new process will not be easy and requires faculty participation.
Mar 5, 1999	Faculty Meeting (Seminar Format)	Dr. Gloria Rogers from Rose-Hulman Institute of Technology presented a seminar to ABE faculty. A pamphlet was distributed that she wrote entitled "Stepping Ahead: An Assessment Plan and Development Guide." [2]
Apr 2, 1999	Faculty Meeting (Short Presentation)	APC arranged for Bob Tenner from Civil Engineering to speak to faculty regarding ABET EC 2000 process.
May 7, 1999	Faculty Meeting	APC presented drafts of the ABE Educational Goals & Objectives for faculty review and comments.
Sep 17, 1999	Faculty Meeting (Workshop Format)	Comments by Dean Huggins (School of Engineering) and Associate Dean Brandt (School of Agriculture) on Outcome-Based Accreditation Issues and Overview of ABET EC 2000. APC members presented: ABE Assessment Process and Timeline, Educational Objectives and Program Outcomes, Introduction to Performance Criteria and Assessment Methods for Program Outcomes, Assessment Tools & Program Outcomes, and ABE/FPE Course Flow Diagrams, ABET-Compliant Course Evaluation Model and Other Future Issues. Small faculty break-out groups to discuss POs and PCs.
Oct 18, 1999	Academic Advisory Board Visit	Similar content to September faculty workshop; gives faculty opportunity to interact with ABE Academic Advisory Board
Nov 5, 1999	Faculty Meeting	APC distributed the updated senior exit survey, course evaluations,

Table 1. Timeline of Interactions with Faculty for Training and Education on Program Assessment

Date	Gathering	Topic
		and a summary of recommendations from the Academic Advisory Board visit.
Nov 19, 1999	Faculty Workshop	This workshop assisted faculty in the development of ABET - Compliant Course Profiles for each of their courses [3]
Jan - July 2000	APC Visit One-on-one with Faculty	APC continued to work with faculty on course profiles for consistency and quality
Sep 14, 2000	Faculty Meeting	APC distributed Outcome-Based Course Evaluation for faculty to complete for each ABE course.
Nov 6, 2000	Academic Advisory Board Visit	Dean Brandt and Dean Huggins updated committee and faculty on accreditation visits in the Schools of Engineering and Agriculture. APC members presented: Overview of ABE Evaluation and Assessment Process; Survey Results (Seniors, Alumni, Employers); Faculty Survey Results of ABE & FPE Courses; Observations and Discussion Points on Survey Results; Existing Gaps & Deficiencies in ABE & FPE Programs.
Nov 17, 2000	Faculty Meeting	APC presented recommendations to faculty for continued improvements. These suggestions were based on input from faculty, alumni, employers, seniors and the academic advisory board.
Dec 15, 2000	Faculty Meeting	APC distributed updated recommendations to ABE faculty & head to continue improvements in ABE Program
Jan. 5, 2001	Faculty Meeting	Dept. Head reviewed plan for implementation of change for Spring semester.

The result of early and continuous involvement of the ABE faculty has been a relatively smooth transition from their initial education about EC 2000 in Spring 1999 to implementation of change in Spring 2001. The faculty understand the language and process of assessment and are familiar with the details of the ABE assessment plan. Many faculty feel that they have a stake in the process and, in some cases, have already implemented changes in their courses based on faculty discussions and early results reporting.

IV. Data Collection & Analysis

APC developed the assessment tools used in the assessment plan in-house. The primary assessment tools consist of graduating senior, alumni, and employer surveys [4], student and faculty course evaluations, and course profiles [3]. Since a considerable amount of data is collected using these tools, APC was concerned with the comprehensive and concise presentation of data to the faculty, as they will ultimately need to implement recommended changes to the program. APC elected to perform a Program Outcomes driven data analysis [2]. Program Outcomes (PO) are broad descriptions of what a graduate will be expected to know and be able to do after completing an academic program [5] and can be used as a basis for common survey questions [4].

Table 2 lists the Program Outcomes for one of the ABE accredited programs: Agricultural and Biological Engineering (ABE). The PO list appears in all surveys typically with two 5-point Likert scales that ask the respondent to assess for each PO the level to which the program addresses the PO, as evidenced by student mastery of skills, and the level of career importance (or anticipated career importance) of the PO. The faculty also evaluated the level to which their course addresses each PO.

Table 2. ABE Program Outcomes (*draft*).	
Graduates of our program will demonstrate:	
Basic Engineering Skills	
PO 1	an understanding of the agricultural and biological engineering profession and practice;
PO 2	the ability to understand and apply knowledge of mathematics, science, and engineering;
PO 3	an understanding of, and the ability to, identify, formulate, model and solve problems for engineering systems;
PO 4	the ability to design a system, component or process to meet desired goal subject to constraints;
PO 5	the ability to design and/or conduct experiments and analyze and interpret data;
PO 6	effective use of appropriate techniques, skills, and state-of-the-art engineering tools necessary for engineering practice;
Professional and Personal Skills	
PO 7	an understanding of the global and societal impact of engineering practice, research and discovery;
PO 8	a knowledge of contemporary issues;
PO 9	appropriate and effective writing, speaking, and listening skills;
PO 10	the ability to function on, and contribute effectively to, a multi-disciplinary team;
PO 11	the ability to understand and practice ethical responsibility in personal and professional life;
PO 12	an appreciation for the value of life-long learning to maintain “life-balance” and achieve maximum potential.

Figure 3, 4, and 5 show the compiled survey results for POs 3, 6, and 8, respectively. In these charts, the first of the paired bars for senior, alumni, and employers represents the level of program achievement of the PO. The second bar represents the perceived career importance of the PO. The single faculty bar is a weighted-average based on course credit hours of the level to which the PO is addressed at the course level. Similar results for all 12 POs were shown to the faculty and the ABE Academic Advisory Board (AAB), which is composed of industry, government, and university representatives. From these results, the faculty and the AAB were to generate recommendations for program improvement.

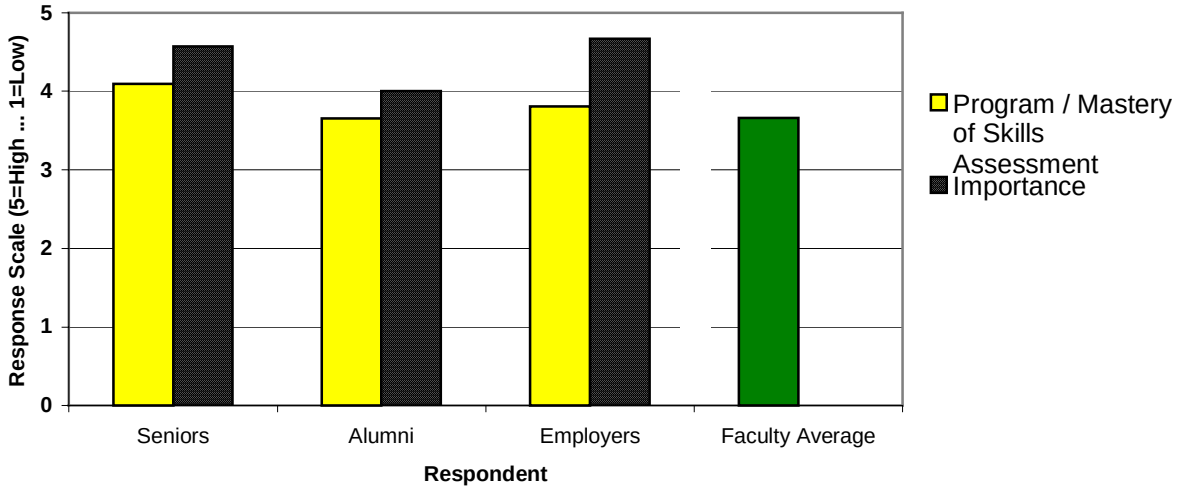

Figure 3. Evaluation of ABE PO 3: An understanding of and ability to identify, formulate, model, and solve problems for engineering systems.

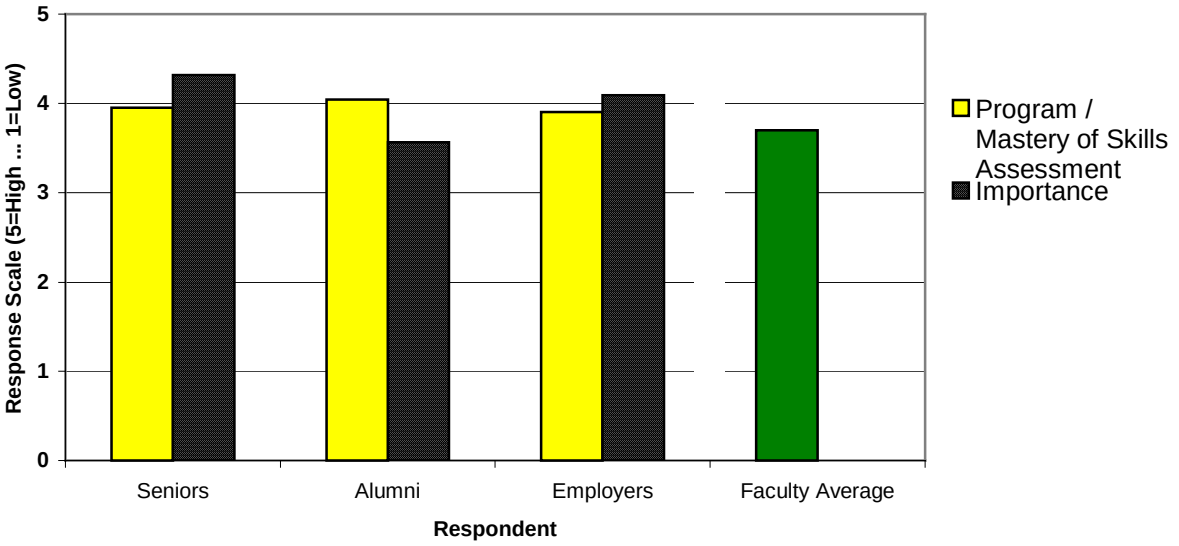

Figure 4. Evaluation of ABE PO 6: Effective use of appropriates techniques, skills, and state-of-the-art engineering tools necessary for engineering practice.

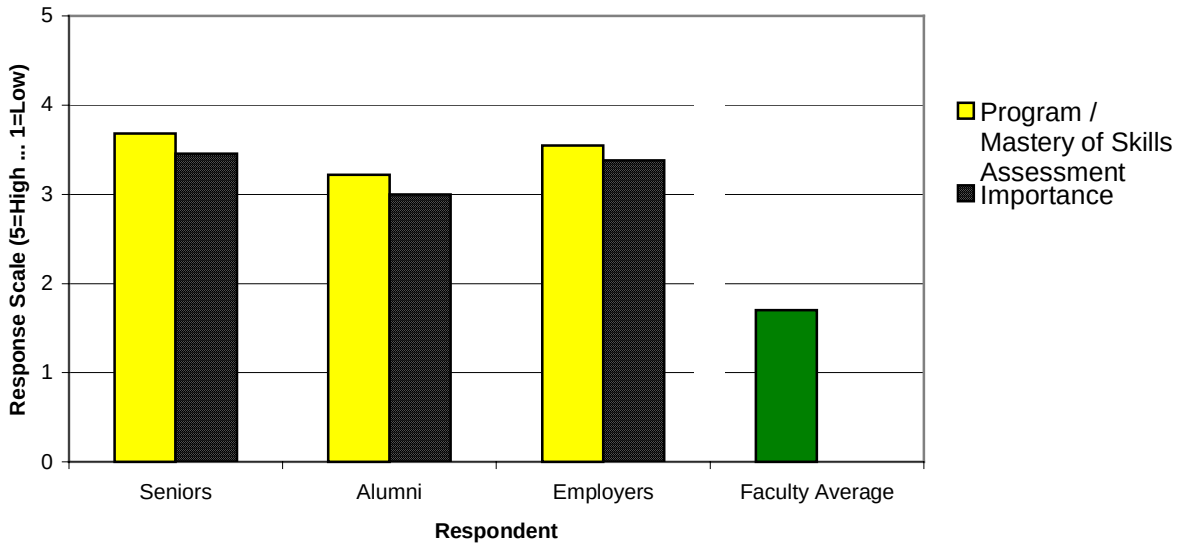

Figure 5. Evaluation of ABE PO 8: A knowledge of contemporary issues.

V. Interpretation of Results and Generation of Recommendations

When identifying priority areas for program improvement, there must be a means for identifying performance gaps and deficiencies in the program. One suggestion for gap and deficiency identification was to set a target for achievement of all POs. It quickly becomes evident that some POs are rated as more important than other POs. For instance, PO 3 and 6 are rated high in importance by all constituents as compared to PO 8 (Figures 3, 4, and 5). Therefore, it is not reasonable to set just one target value for all POs. This leaves setting target values for each PO; this is a more difficult task. What is the "right" target value for each PO?

At the recommendation of the AAB, ABE decided to focus attention on POs for which there was a considerable difference in the paired bars, with greater emphasis being placed on the alumni and employer results. Using this method of gap and deficiency identification leads to some concern over PO 3 since the level of importance always scores higher than program achievement. On the other hand, PO 6 and PO 8 are not cause for concern since most constituents rate the program achievement higher than the level of importance.

Once the top priority POs are identified, specific recommendations are made based on responses to open-ended survey questions, faculty rating of POs for individual courses, course profiles, and advice of the Academic Advisory Board. APC generated a first draft of the recommendations, which were presented to the faculty. Based on faculty feedback, the recommendations were refined by APC and presented a second time to the faculty and the department head. Table 3 is an abbreviated list of the revised recommendations made to the faculty with notes of the primary sources of data that influenced the writing of the recommendation. The responsibility of seeing

the recommendations implemented during the Spring 2001 semester currently rests with the department head and faculty assigned to ad hoc committees.

Table 3. Recommendations to ABE Faculty & Head To Continue Improvements in ABE Program

Recommendation	Source[a]
1. Form a faculty committee to review the two-semester sophomore level class sequence to address the following specific issues: • Create room for a significant design experience (i.e. a separate design class). • Formalized instruction on problem solving strategies. • Incorporate more open-ended and real-world problems. • FPE/ABE co-existence.	PO 3, 4 S
2. All ABE courses should be encouraged to incorporate more problem solving strategies, open-ended problems, and real-world problems. ABE classes need to update their "course learning objectives" (CLO's) to address these issues.	PO 3, 4
3. ABE 325 and ABE 330 need to incorporate more design problems and introduce more constraints in their designs.	PO 3, 4
4. Department should direct/redirect more resources (personnel, facilities, space, funds) to teaching laboratories and equipment.	S
5. Department should hire a part/full time technician dedicated to teaching laboratories.	S
6. ABE 430 (Instrumentation and Measurement) should become a required class for Mechanical Systems Engineering students, either as a restricted technical elective or be substituted for another class in the curriculum.	PO 5 S
7. Hire a part-time staff person to help with technical communications and presentation skills across the curriculum to: • Provide instructions and develop model documents. • Help with professional editing of papers and reports. • Provide instruction and testing on writing professional letters and memos in sophomore and senior seminar courses and require them in all other classes for submitting papers and reports. • Provide instructions, ask for presentations, videotape and critique student presentations in various classes.	PO 9 S
8. All ABE courses that have PO 9 as one of their course learning objectives should make serious efforts to improve their communication component.	PO 9 S
9. Form a faculty committee to review freshman, sophomore, and senior seminar courses as a cluster. Focus should be on ABE POs that address professional and personal "soft" skills and particularly the ones involving global and societal impact of engineering practice, knowledge of contemporary issues, ethical responsibility in personal and professional life, and life-long learning. Issues related to other support functions and activities (i.e., undergraduate research, Co-op) should also be addressed. Graduation requirement of lower level seminars should be addressed.	PO 7, 8, 11, 12
10. Develop, distribute and publicize "Code of Ethics of Engineers" through various academic and extracurricular avenues in the department.	PO 11

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Recommendation	Source[a]
11. Provide regular curriculum updates and training opportunity for faculty involved in student advising and counseling. Better advising and counseling require time, training, support, and encouragement.	S
12. Department Head should provide significant incentive, support and opportunities for faculty to learn about new teaching methodologies and learning paradigms.	S Faculty

[a]PO = Program Outcome; S = Survey Free Response

The final recommendation to the department head is to establish a permanent faculty/student/ staff committee to: follow-up on the implementation and documentation of recommendations, monitor progress of the ABE improvement process, and monitor ongoing continuous improvement activities.

VI. Conclusion

The degree of success in closing the continuous improvement loop the first time and every time ultimately depends on faculty education and support. Early and continuous education of the faculty on the goals, mechanics, and progress of the assessment process facilitates the implementation of possible changes in the curriculum. Still, much attention must be devoted to the comprehensive, comprehendible, and unbiased report of the assessment data analysis and interpretation. The faculty must discern from the data what elements of the program need change. Ultimately, if continuous program improvement is to be achieved, the faculty must agree to (1) what program deficiencies can and will be addressed, (2) who will be charged with implementing changes, and (3) how the changes will be implemented and assessed.

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