

Using Multisource Feedback in the Classroom: A Computer-Based Approach

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Abstract—This paper shows the application and results of a computer-based approach to solicit student self- and peer assessment and multisource feedback on student learning outcomes linked to the Accreditation Board of Engineering and Technology's EC-2000. The issues addressed include the efficacy of student self and peer review, correlation with faculty grading, faculty and student acceptance, and process management. Results demonstrate that multisource feedback supports the development of specific student learning outcomes when used in conjunction with team-based projects.

Index Terms—<AUTHOR: please supply index terms. E-mail keywords@ieec.org for info>.

I. INTRODUCTION

MULTISOURCE assessment is a formal process that provides critical information from several sources, such as peers, self, and instructors, on student competencies and specific behaviors and skills, affording the student a better understanding of personal strengths and areas in need of development. In spite of the growing number of team-based projects being used in colleges and universities, the application of multisource assessment and feedback processes to support outcome assessment activities has been limited. However, the use of such feedback processes has been limited because systematic methods for peer evaluation and feedback have been unavailable. This paper reviews the application and results of Team Developer [1], an automated multisource assessment survey used with thousands of engineering students in several programs, including New Jersey Institute of Technology (NJIT), Ohio State University and University of Pittsburgh.

Team Developer, a computer-based survey, is designed to provide each student with constructive, developmental feedback regarding his or her effectiveness on several specific cognitive and behavioral skills. The basic application allows student team members to rate both themselves and their teammates to identify skills based on behaviors that have been found to be important for practicing engineers. The data are collected via computer and compiled by an administrative application. Reports are automatically generated, giving each student a confidential,

developmental feedback report that presents self and team ratings on each survey item and pinpoints overall strengths and areas for development. Gaps between self-perceptions and the perceptions of others are clearly shown. Specific suggestions for development, keyed to the behavioral areas, are provided to assist team members in developing action plans based on their personal feedback. A brief sample of a student report is included in Appendix A.

II. RATIONALE FOR MULTISOURCE ASSESSMENT IN THE CLASSROOM

Student learning outcome assessment has become an increasingly important focus for higher education institutions. This focus is primarily a result of pressure from both industry and academic accreditation entities to incorporate a broader set of student learning outcomes and sound assessment techniques into individual courses and educational programs [2]. For example, the Accreditation Board of Engineering and Technology (ABET) has incorporated 11 student learning outcomes and assessment as key in its Engineering Criteria 2000 (EC-2000) [3]. According to the ABET criteria, the focus of an institution's assessment efforts should be on the measurement of student learning outcomes in a systematic and valid manner.

In general, an outcome-driven assessment system should provide critical information to educators on the effectiveness of the design and delivery of an educational project, activity or program. Until recently, few educational institutions employed a comprehensive system for measuring program results in terms of student learning outcomes. And of those that have, the focus has been on the traditional set of student learning outcomes in specific technical and basic science areas. However, the movement in industry for practicing engineers, supported by ABET, is the drive to prepare students for the professional work environment they will encounter upon graduation. Professional engineers will need competencies beyond the traditional knowledge of science and basic engineering principles. They will require skills to help them function in multidisciplinary teams and work with complex systems of products and services; they will have to strive toward continuous self-learning and make decisions within the proper societal and environmental contexts.

To accomplish this new kind of skill development, engineering faculty members have increasingly turned to the use of cooperative learning techniques and team-based projects in the classroom [4]–[6]. These techniques promote interdependence among students, encourage interaction, require information sharing, and typically include the use of team-based projects as cornerstones of the learning process. One of the most obvious indicators of successful cooperative learning is the shift of

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the student's role from a passive receiver of information to an active participant. In a cooperative learning environment, students themselves are often in the best position to provide one another with meaningful feedback regarding both their technical and interpersonal performance.

III. BENEFITS OF USING MULTISOURCE FEEDBACK IN THE CLASSROOM

A formal multisource feedback approach provides students and educators with important benefits. One main benefit is perspective: the feedback providers are those with whom the student interacts most closely. When working in teams, fellow students have had first-hand ample opportunities to observe behaviors, contributions, and communication skills. The instructor may be able to observe brief, small samples of behavior, but not to the degree of student team members.

From the students' perspective, introducing a systematic survey process helps to reinforce key learning objectives. The behaviorally specific information contained in a survey like the Team Developer helps to define and make salient to the student what is required in order to perform effectively [7]. This is especially important when considering the 11 ABET EC-2000 student learning outcomes. In addition, the fact that the information is presented as part of a formal feedback system sends a strong message to students that performance should be improved. This message in and of itself can often encourage people to evaluate their own performance and establish improvement goals [8]. Recent research on the use of peer feedback systems suggests that students are likely to demonstrate changes in behavior and skill acquisition simply by completing the feedback instrument. For instance, Dominick *et al.* found that students who completed a peer feedback instrument, but did not actually receive feedback, were just as likely to improve their performance as students who actually received feedback [9].

From the faculty perspective, the information collected from a multisource feedback process can be of tremendous value for teaching and assessing course outcomes. By reviewing feedback results, instructors can better tailor their teaching activities to specific needs identified for individual students and the total class. Additionally, tracking scores on targeted competencies can provide measures of curriculum effectiveness.

IV. USING THE COMPUTER FOR SURVEY ADMINISTRATION

One of the biggest challenges many faculty members face when attempting to implement multisource feedback processes is finding the time to collect, tabulate, and then disseminate information. A computerized format like Team Developer's helps to eliminate many of these obstacles. Using a computerized survey means that data can be collected and analyzed quickly; there can be a fast turnaround time for providing feedback. This also means that more time can be spent in reviewing information and ensuring that the feedback process is a meaningful one for students and instructors.

While an automated system is ultimately a time saver, there is usually an initial need for more up-front time to ensure that the process operates smoothly and efficiently. A multisource eval-

uation process will become far more effective if the instructor takes the time to discuss the process with the students. Students need to be aware of the rationale for receiving feedback from peers. Additionally, they must understand how the competencies being measured are linked to the course objectives as well as to their own professional skill development.

V. IMPLEMENTING THE FEEDBACK PROCESS

Even a well-designed and automated feedback process will fail to produce meaningful results if it is not implemented with care. To begin with, feedback providers and recipients should be made aware of how the instrument was developed and, more importantly, how the information they provide will be used (for example, as developmental improvement rather than evaluative criteria). One of the advantages of Team Developer is that feedback can be collected and provided in ways that ensure confidentiality. Ensuring confidentiality is often an important factor, especially for people who are new to the peer feedback process.

In order to encourage improvement, the multisource evaluation instrument should be administered more than just once during the time that the team of students is working with one another. Two administrations of the instrument (at the midpoint and end of a semester) have worked well with Team Developer. The midpoint assessment can be conducted after the students have had sufficient time to observe skills and behaviors of their fellow team members. By the end of the semester, the students will have adequate opportunity to react to the feedback they received earlier and implement their improvement efforts.

Another factor that can help to make the most of the feedback process is instructor involvement. For instance, at one institution, instructors would make themselves available to students who wished to discuss the feedback they had received [10]. In some cases, instructors facilitated discussions among peers in order to help them better understand the feedback they had provided to one another. Another way to strengthen the impact of a peer feedback process is by requiring students to prepare development plans based upon their feedback. Appendix B provides an example of how students can approach individual development plans.

VI. USING MULTISOURCE FEEDBACK TO ASSESS EC-2000 LEARNING OUTCOMES

Several undergraduate and graduate engineering programs have incorporated the Team Developer into their curriculum in order to assess student learning outcomes such as those specified by EC-2000. For example, NJIT uses the Team Developer process to assess undergraduate engineering students working on team design projects [11]. The process at NJIT involves students rating self and peers on 48 behaviorally specific items relating to nine core learning outcomes: analytical thinking, communication skills, creative problem solving, project management, research skills, self-learning, systems thinking, teamwork, and technical competence. Each of these outcomes is linked to ABET 2000 Criteria 3 (a-k).

Self and peer assessments are based on the observations of specific behaviors of students working on classroom projects throughout the semester. Students are engaged in frequent

interaction while working on these projects, thus providing a good opportunity to observe specific skills and behaviors of each other. Students are provided with results showing how they were rated on each of the nine learning outcomes. These peer ratings are compared with the students' own self-ratings as well. Students are encouraged to use the reports to plan their own development activities and monitor progress over time. Additionally, faculty members receive information about how their classes fared in the aggregate ratings of the nine learning outcomes as perceived by their students, thus allowing them to review how educational objectives are being met and to decide on changes for the future.

VII. SELECTED RESULTS FROM VARIOUS INSTITUTIONS

Data on student populations using the Team Developer have been collected for almost a decade. Psychometrically, the survey has proven to be both reliable and valid. Interrater reliability for a given sample typically ranges from 0.37 to 0.72. Internal consistency estimates range from 0.78 to 0.94. One way to look at validity is to compare student ratings with those of trained observers. In one class sample, graduate psychology students were trained to observe specific behaviors in a team-based project context. Thirty students worked in teams of six. Each team was observed, at work, by a designated graduate student. Correlations between these trained observers and student peer ratings ranged from 0.48 to 0.61. Average convergent and discriminant validity were 0.55 and 0.34, respectively [12].

One of the primary assessments of interest to faculty is the change in learning outcome ratings over time. As indicated earlier, one of the more effective ways to use multisource feedback processes in the classroom is to administer assessments at different points in time in the course. Many faculty members administer the Team Developer twice during a semester, once in the early part of the team project and again at the end of the project. This repetition allows students and faculty to see what changes in self and peer scores have occurred during the semester. Of course, the assumption is that a positive change in scores, especially peer scores, reflects development of measured learning outcomes.

In one engineering institution, data were gathered from six separate classes with a total of 178 students involved in the Team Developer process. The Team Developer was administered twice in each class. The first application occurred during the middle of the semester and was used to provide developmental feedback to class participants on four team-related learning outcomes: collaboration, communication, decision making, and project management. The second application occurred during the final week of class, and feedback was delivered to students during their final presentations.

The results demonstrated that students improved in all four areas (Table I). Specifically, a series of paired *t*-tests found significant differences between the means for the first application and the second application for learning outcomes measured.

At another engineering college, data were gathered from three separate sections with a total of 158 students participating. Student self and peer ratings on the nine learning outcomes were correlated with grades given at the end of class [13]. Results

TABLE I
AVERAGE PEER RATINGS FOR STUDENTS
BY LEARNING OUTCOME (RATING SCALE 1 = NEVER TO 5 = ALWAYS)

Learning Outcome	Time 1	Time 2	t value
Collaboration	3.71	3.83	2.68**
Communication	3.55	3.74	4.67**
Decision Making	3.46	3.65	5.31**
Project Management	3.51	3.72	4.62**

(** $p < .01$)

TABLE II
CORRELATIONS OF PEER/SELF ASSESSMENTS BY LEARNING OUTCOMES
AND GRADES

Learning Outcomes	Peer-Grade	Self-Grade
Analytical Thinking	.32*	.35*
Communication	.22	.38*
Creative Problem Solving	.32*	.35*
Project Management	.39**	.31*
Research Skills	.59**	.41**
Self-Learning	.60**	.54**
Teamwork	.22	.21
Technical Competence	.35*	.23
Systems Thinking	.38*	.28

(* $p < .05$, ** $p < .01$)

demonstrate that student peer ratings are consistent with faculty grading on several dimensions. One interesting finding is the variation found among correlations between self and peer ratings and students' grades in freshman engineering design classes (Table II). There are several potential reasons for the low relationships between grades and self and peer ratings, especially in communication and teamwork. Through interviews, it was found that faculty members were generating the majority of their grading on technical competency, with less attention on the cognitive and behavioral skills measured by the Team Developer. The data show that grades do not take into account such important factors as teamwork and communication skills. This finding was substantiated through student course surveys in which students rated the extent to which the nine learning outcomes were emphasized during the course.

VIII. CONCLUSION

As engineering educators increase their attention to developing and assessing student learning outcomes, peer evaluation processes will play an integral part in the education process. First, these studies show that students can play an active role in their own development and assessment. However, these self-assessment skills need to be developed by providing a structured process to facilitate their learning. Second, peer feedback processes can have an impact on developing student learning outcomes as prescribed by ABET EC-2000. An educational tool, such as Team Developer, can support an institution's objectives in the development and assessment of student learning out-

TABLE III
SAMPLE SECTION OF STUDENT REPORT

ITEM RATINGS BY STUDENT LEARNING OUTCOME			
		Self	Team
COMMUNICATION			
Helping to sustain an environment where people feel free to speak candidly, articulating ideas clearly and concisely, listening and demonstrating an understanding of other perspectives.			
Active Listener		3.8	3.8
Listens attentively to other team members without interrupting		4.0	4.1
Conveys interest in what others are saying		5.0	3.3
Provides others with constructive feedback		4.0	4.1
Restates what has been said to show understanding		3.0	3.7
Clarifies what others have said to ensure understanding		3.0	3.4

TABLE IV
SAMPLE STUDENT DEVELOPMENT PLAN

Development Area	Action Steps	Completion Date
<i>Persuading others to adopt my views.</i>	Vague: <i>Present better. Think out arguments in advance of each meeting.</i>	5/14
	Specific: <i>1) Prepare in advance a fact-based argument to support my position on XYZ issue. Seek time to present my position at our next meeting.</i>	5/14
	<i>2) After the meeting, seek feedback from two other people on the impact of my argument.</i>	5/18
	<i>3) Read <u>How to Sell Your Ideas</u>.</i>	5/31
<i>Generating alternative solutions.</i>	Vague: <i>Be more creative by thinking about things from different perspectives and talking to people from other backgrounds.</i>	6/30
	Specific: <i>1) Prior to making a decision on XYZ, seek the input of at least three people whose backgrounds are different from one another and from my own.</i>	6/15
	<i>2) During the next month, keep a notebook handy to write down new ideas. Review my ideas once a week with a view toward how they will help our team solve problems.</i>	6/30

comes. Team Developer data on hundreds of students have been collected. These data show that student self and peer ratings can be consistent with faculty perceptions of student performance as measured by grades. However, important student learning outcomes may not be reflected in traditional grading schemes. Multisource feedback may provide a method to grade students in more qualitative areas, such as teamwork and communication. Finally, when the process is administered several times over a period of time, individual team members improve on learning outcomes significantly after peer feedback. This type of information can support faculty members in their continuous improvement of academic programs.

APPENDIX A
TEAM DEVELOPER

Sample section of student report. (See Table III.)

APPENDIX B
SAMPLE DEVELOPMENT PLAN

Now it's time to decide how you are going to act on the information provided in this report. Use the planning sheet on the next page to address the development areas identified in your feedback. If necessary, make copies of the form.

To use the planning sheet, describe the development area you want to focus on in the first column. Rather than working on an entire dimension all at once, try to select development areas related to specific survey items. In the second column, list the action steps you will take to improve your performance. You may want to look back to the development suggestions you checked or highlighted as you do this. Also, obtaining additional input from team members, friends or your instructor can help you prepare more effective action steps. For example, your instructor, who is familiar with your report, may be able to involve you in projects that will aid in your development or direct you toward additional resources. Finally, record your target completion dates in the third column.

You will have more success in improving your performance if your action steps define *precisely* what you are going to do. You will want to avoid vague, general action steps that are difficult to measure. With clear action steps, you can determine whether you've met, exceeded, or fallen below your objectives. It also helps to have more than one action step for a particular development area. Examples of vague and specific action steps are shown below to guide you as you write your own development plan. (See Table IV.)

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