Short-Term Course Assessment, Improvement, and Verification Feedback Loop

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Abstract

An assessment-improvement feedback process is presented for improving the students' classroom learning experience. The new process uses multiple short surveys during the term to identify strengths and weaknesses in a course curriculum and in an instructors teaching style. The surveys questions used in the process are derived directly from course educational objectives. The advantage of the new process is that it reduces the assessment-improvement-verification turn around time; addresses the problem of varying class dynamics; and thoroughly identifies class problems. The paper also presents and discusses the results of applying this new process to three freshman engineering classes.

I. Introduction

Effective assessment of student learning in an engineering classroom, and the implementation of an assessment-improvement feedback loop are integral parts of the ABET accreditation process, (see 2001-2002 Criteria for Accrediting Engineering Programs[1]). Unfortunately, in an engineering environment, the assessment-improvement feedback loop is primarily applied to student knowledge through traditional or innovative testing, followed by curricular improvement. It is our view that the effectiveness of a course is governed by more than just student knowledge. Successful courses excite and interest students, provoking critical thinking. They instill students with a level of confidence about their new abilities, and consequently motivate students to study. The student learning experience, however, is often under emphasized in the assessment process.

Traditionally, assessments taken to measure the students learning experience are done only once at the end of each term, often using some standardized institutional survey. This approach has several major shortcomings. First, it leads to long turn-around times in the assessment-improvement feedback loop. Assessment, improvement, and then verification that changes made to improve the learning experience were indeed effective, can take up to two years for classes taught annually. Second, end of term assessment results are specific to the group of students participating in the assessment. Since the learning experience can be very subjective, and class dynamics vary from term to term, course changes to improve the learning experience which were based on an assessment taken at the end of a course may not be beneficial to students in future courses. Finally, because these traditional assessments are often based on an institutional standard, they do not address the students learning experience in the light of the course's educational objective. It is important, for example, in courses emphasizing teamwork, that the assessments address the students experience in course related team activities in order to provide useful information for improving these team activities.

The shortcomings of using standardized end of term assessments can be overcome by using a series of multiple short assessments during a course, in which the assessments are designed specifically for the course. This process substantially reduces the assessment-improvement-verification turn around time, making it easier to determine the effectiveness of teaching or curriculum changes on the learning experience. It also addresses the problem of varying class dynamics since changes in course curriculum or the instructors teaching style directly benefit those students participating in the assessment. An additional benefit of the shortened assessment period is that the student memories are fresh with the problems they faced during the past weeks, and so their responses to assessment questions are more accurate.

In this paper we describe a mechanism for implementing a short term assessment process and describe our application of this mechanism to three freshman engineering classes. The remainder of the paper is divided into four sections. In Section II, we discuss the formal assessment mechanisms developed to evaluate the student learning experience. In Section III, we discuss how the assessment mechanism was applied to three freshman engineering classes and how educational objectives for these courses were used in the assessment process. Results from the assessment process are discussed in Section IV. Our conclusions and recommendations are presented in Section V.

II. Assessment Mechanism

The goal of our short term assessment process was to assess the effectiveness of a course, identify problems, and then use this information to modify and improve the course - specifically in the area of improving the student learning experience. As such, the assessment mechanism should satisfy the following criteria: a) the mechanism needs to assess the student experiences in the light of course specific educational objectives, b) it needs to be easy to implement, since it would be used several times a term, and c) it needs to guarantee student anonymity.

The mechanism used consisted of three in class surveys and one in class peer review. The peer review was an oral class evaluation conducted by an outside professor without the teaching professor present. A flow chart of the assessment mechanism is shown in Figure 1 and discussed below.

Step one in the assessment process is to formalize the educational objectives for the course. Educational objectives include: a) learning objectives for the course, b) learning objectives for the class projects, and c) objectives for the teaching style and effectiveness. Each of the objectives represents characteristics in the learning environment that could be used by a professor to improve the course outline, syllabus, the project complexity or relevance, and the teaching style, homework, or tests.

Course learning objectives address specific skills or knowledge the students are expected to acquire during the course. A typical objective in an engineering Static course might be "Learn to draw a Free Body Diagram". Project learning objectives address the specific skill or knowledge students were expected to receive from working on the project, for example, "Divide up a task among members of a team". Finally, teaching style learning objectives address how well the professor presents the material, for example "Provide the student with an enthusiastic presentation of the material". Once the educational objectives for the course are established they can be used to generate survey questions.

Step two in the assessment process is to develop survey questions and execute the survey. In our ten week quarter, the surveys were performed about once a month. Questions were formulated so that students could rate their responses on a scale of 1 to 5. This approach assured the anonymity of the students and simplified the evaluation of the survey. Survey questions were derived from the educational objectives developed in step one. For example, if one of the objectives was for students to work in a team, the corresponding question might ask students to rate the improvement in their teamwork skills. The goals of the questions are to assess the students learning experience. This includes the students' perception of what they have learned, their confidence level as related to the course objectives, or their perception of how well the professor is teaching the course.

After each survey was performed, the results are compiled and discussed among faculty members. At that time, a course of action is planned for improving the students learning experience during the next third of the term. In addition, questions for the next survey are formulated. Successive surveys should include: 1) questions from previous surveys, to identify trends; 2) new questions, to address learning objectives specific to the next segment of the term; and, 3) clarification questions, when the results of the previous surveys were inconclusive or unclear.

Step three in the assessment process is the peer review. The peer review follows the second survey and is used to further clarify items from the previous two surveys and to solicit help from students for improving the class where the surveys showed a decreasing trend.

The final step in the process is to re-evaluate the assessment results and make any necessary correction to the curriculum for the next course offering.

III. Assessment Application

Our short term assessment mechanism was applied to three classes: MME105-Engineering Graphics and two sections of MME181-Introduction to Design. Both classes are freshman classes with approximately twenty students in each class. Shorter lectures combined with a strong lab component of both classes warrant for emphasized experiential learning[2,3]. Also emphasized in both classes is development of critical thinking, through individual, team and project evaluation. The classes are briefly described below.

MME105 is a required Computer Aided Design (CAD) class (three quarter credits). The class covers the principles of engineering graphics, 3D solid modeling and sketching. The course is comprised of three hours of lecture and three hours of lab per week. Approximately half the lab hours are spent working on CAD. The other half is used for sketching projects or in class activities. The course concludes with a team design project where students are asked to design a multiple part assembly and create a complete drawing package for their design.

MME105 has been taught by Dr. Greg Mason for the past three years and has a well developed curriculum. The course usually receives moderate evaluations when using the standardized University end of term survey, which is typical of freshman courses.

The second class participating in the short term assessment process is MME181 - Innovative Design. MME181 is a required freshman design class (two quarter credits) that covers the principles of design and introduces students to a range of mechanical engineering topics, including strength of materials, statics, thermodynamics, fluid dynamics, and electro-mechanical devices. The course is primarily a lab course. Students meet for four hours a week where they work in teams on given design projects formulated to help develop analysis and critical thinking skills. Students are also required to produce memorandums and written reports, perform in class oral presentations, and generate web pages. Overall, the class is designed to develop both technical and communicational skills of students early in their career.

The course is taught by Dr. Teodora Shuman. This is the first term that Dr. Shuman taught this course. Based on the departments recommendation, she has heavily revised curriculum from past years. A freshmen design class described in Safoutin et al.[4] was used as a model. The course evaluations in previous years, when using the standardized University end of term survey, were generally above average for a freshman course.

The educational objectives of both classes were divided into general course learning objectives, project objectives, and teaching objectives, as previously mentioned. The formulation of the educational objectives was done in terms of specific observable actions, such as draw, create, describe, name, or design. This approach, originally suggested by Felder and Brent[5], was used by Safoutin et al.[4] in a freshmen design course. This work found that educational objectives formulated using this approach are very helpful in creating the survey questions. That is, it is much easier for a learning assessment survey to target specifically articulated learning objectives.

Figures 2 and 3 contain MME 105 and MME 181 general course learning objectives, respectively. Specific project learning objectives are not all listed herein, because they were abundant. For example, MME 181 contains two short individual, and two long team projects. Each of these projects contains their own set of learning objectives. By way of example, the first MME 181 project is to design a display that illustrates an engineering profession of the student's choice. The display is accompanied with an informal in-class presentation and a written memorandum describing the project requirements, constraints, prototypes considered, reasons for choosing the final design, and an evaluation of the final display design. The learning objectives for this project are given in Figure 4. The other three MME 181 projects build on the learning objectives for the first project outlined above and has a similar set of their own learning objectives (not shown herein).

Finally, the teaching objectives for both MME 105 and MME 181 courses are outlined in Figure 5. They are the same because they are only used to assess general teaching quality. These objectives are derived from the Universities standardized end of term assessment survey, but are modified to reflect the experiential learning nature of the courses.

The educational objectives of Figures 2-5 were then used to formulate survey questions. The questions were divided into questions for assessing the course and the projects learning objectives, and questions for assessing teaching objectives. Project objectives questions were asked only in the survey administered for the period of time corresponding to the time that project was utilized in the course. The surveys in both classes were taken during the third, the sixth and the tenth week of a ten-week quarter. Also, in the last week of the quarter, the peer-evaluation was held, and the standardized university end of term survey was administered, both of which were analyzed in conjunction with the short-term assessments. To identify trends, several of the questions were repeated, or reworded in successive surveys. The actual survey questions are provided in Tables 1 and 2.

IV. Assessment Results

The results of the short term assessment process for MME105 and combined results for the two sections of MME181 are summarized in Figure 6. This figure only shows results for questions that were repeated each survey. Survey results for all questions are provided in Tables 1 and 2, for MME 105 and MME 181, respectively.

The results for MME105 show a consistent decline in the effectiveness of the professor, but a consistent increase in the students perception of how much they had learned. The decline in the professors effectiveness is shown to be between 4.32 ± 0.89 in the first Survey to 3.75 ± 0.68 in the third Survey. A similar decline was seen in the rating of the professors enthusiasm. The decline in the professors effectiveness and enthusiasms was discussed with the class during the in class peer evaluation. Orally, students did not indicate that there was a decrease in the professor's presentation, but instead, a decreased interest in the material presented later in the term, which is also evidenced in the decrease in rating for student's interest in taking the class from 3.84 ± 1.12 in first Survey to 3.67 ± 1.19 in the third Survey. By the end of the term, the glamour of using a CAD system to create models had worn off and students felt they were being asked to do the same thing over and over. This is an inherent problem with classes such as MME105, where each proceeding topic relies on the previous topic.

On the positive side, the surveys showed a steady increase in the student's perception of how much they had learned. This is evidenced through the increase in their ratings of their sketching skills and ability to use CAD to model and convey ideas (see Table 1).

While the assessment results are not optimistic, they do reveal information that could not be gathered using a traditional end of term assessment mechanism. First, that the interest in the course material decreased due to the repetitive nature of the curriculum. Re-arranging the order in which the material is presented, or providing different types of homework throughout the term may help relieve the student boredom. Second, the peer review helped to identify specific areas where the professor could improve his presentation style.

MME181 shows a relatively unchanged performance of the Professor. Overall that performance was evaluated as good (See Table 2). The results obtained from the first short-term assessment were extremely valuable to show the instructor that the students were satisfied, and gave confidence that continuing similar performance would assure overall success of the class.

The class interest shows a small decline from 4.21±0.91 in the first Survey to 3.95±0.88 in the third Survey. The peer evaluation indicated that the decline was due to a few hard assignments and one particularly long lecture. Another reason for the decline may be attributed to those students who decided, during the course of the term, not to pursue engineering.

The short-term class assessment proved especially valuable in assessing guest speakers and short lectures. The first Survey included questions used to evaluate a guest lecturer who talked about web page design. The third Survey included a question about a guest lecturer from TauBetaPi. Since the assessments were administered while the student's impressions of these lectures were fresh, they were able to accurately rate the usefulness and the effectiveness of the lecturer. After the first assessment showed that students rated the web design guest lecture approximately one point lower than other parts of the class, follow up questions were designed for the second assessment to identify the source of the students dissatisfaction. Those questions asked whether the student felt rushed and whether there was enough help in the classroom during the lecture. Since results of both questions showed overall satisfaction (see Table 2), the professor decided to spark an in-class discussion on what was wrong and what could have been done better next time. The results of that discussion were that: 1) students would prefer to get the assignment ahead instead of during the class, and 2) they felt that they need additional written documentation on web page building techniques. As a result of the assessment and in-class discussion the web page lecture and assignment will be modified the next quarter to address the students concerns.

The short assessment process also proved valuable for making minor curricular changes during the quarter. For example, in MME 181, during the first assessment, students rated their knowledge of the main steps in the design process relatively low, i.e., 3.32±0.71. This was attributed to the ineffectiveness of the lecture on the design process. By calling attention to the design process in successive design projects and lectures, students ratings were improved to (3.76±0.68) by the end of the quarter. Similarly, the professor was able to increase the ratings on how assignments were graded.

V. Conclusions

Overall the short term assessment process worked well for assessing the students learning experience and their perception of the effectiveness of the professor. The process was especially useful for isolating problematic lectures and specific curriculum related problems. These are issues, which would have been overlooked by traditional end of term assessment tools. The surveys clearly identified specific class weaknesses and those were either corrected in the same term, or will be corrected in the next term.

The peer review was found an incredibly valuable tool. It provided the opportunity to discuss the effectiveness of the class with the students. The peer review conducted at the end of the term suggested changes that will be applied to class offered next term. However, the results from a peer review administered after the second survey could be implemented in the same term and to the same group of students. Peer review combined with the results of short term class surveys is especially valuable because the reviewers have the data from previous surveys on which to base their discussions with the students.

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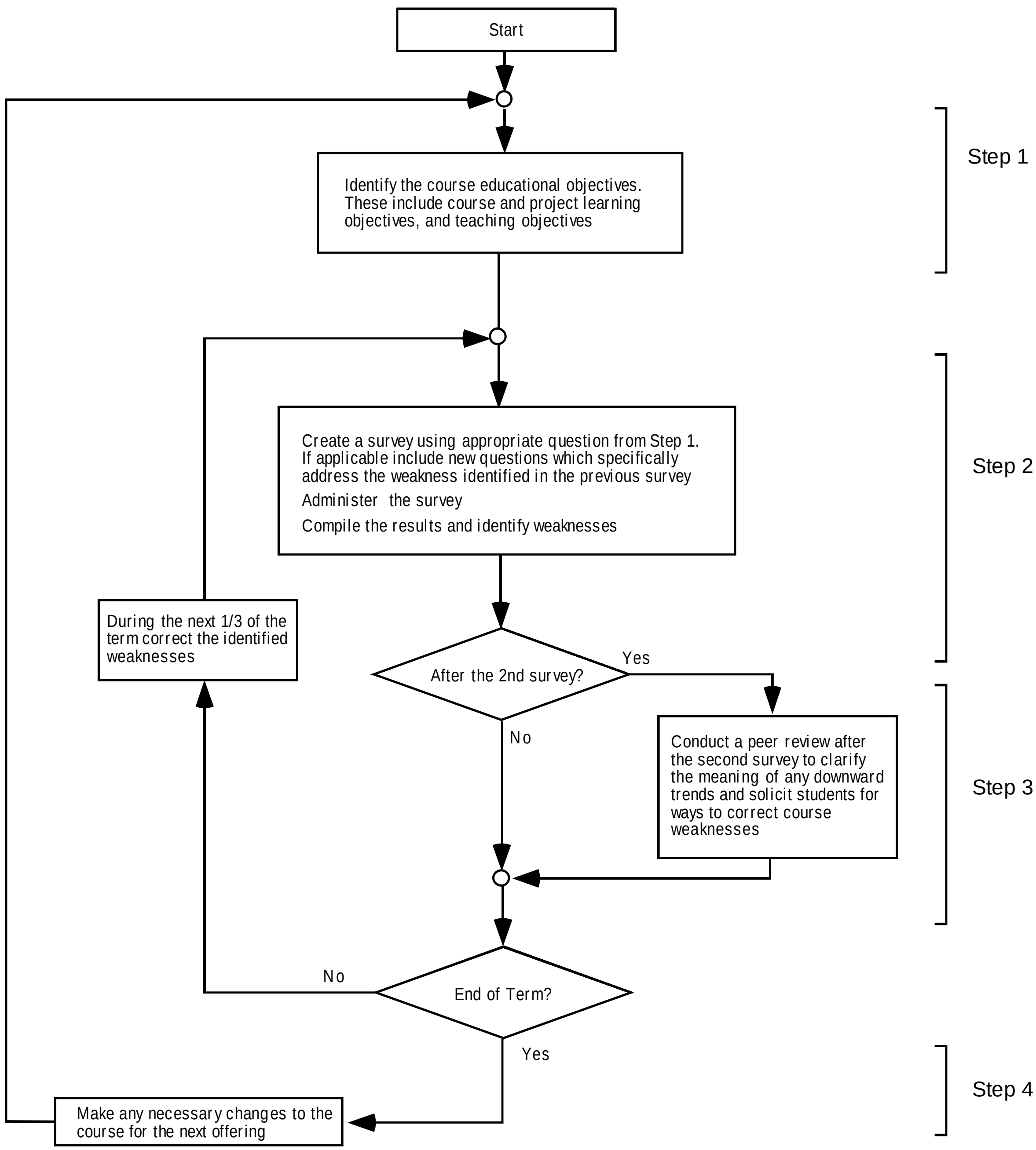

Figure 1. Assessment mechanism flow chart

MME 105 Course Objectives:
Visualize object in 3 dimensions from 2D drawings and sketches
Read and interpret engineering drawings
Mathematically model 3D objects using solid modeling CAD software
Draw dimensioned orthographic engineering drawing using CAD or by sketching
Compute tolerance stackup
Technically illustrate parts and assemblies
Draw (using CAD) or sketch auxiliary and sectioned views

MME 105 Project Objectives:
Read and apply dimensioning and tolerancing
Create complete working drawing for a design

Figure 2. Course and Project Learning Objectives for MME105

MME 181 Course Objectives:
Describe main design steps
Identify functional requirements and constraints for a design assignment
Design and document displays, presentations, a web-site, and two devices
Dissect an engine
Name major engineering disciplines
Describe some of jobs that are done by professionals in major engineering disciplines
Estimate the importance of technical communication to engineering practice
Write memorandums and team reports
Maintain an engineering journal
Design presentations using Microsoft Power Point
Present with a PC and a projector
Post designed web site on the World Wide Web
Assess the importance of teamwork to engineering practice
Work in at least two different 3-5 person teams

Figure 3. Course Learning Objectives for MME181

MME 181 First Project Objectives:
Identify functional requirements and constraints for the design assignment
Name and explain main design steps
Describe what engineers of your choice do
Describe types of work of other engineering disciplines
Document your work in memorandum style

Figure 4. Learning objectives for the first project in MME181

MME 105 and MME 181 Teaching Objectives:
Provide an enthusiastic atmosphere for learning
Use class time effectively
Assign an appropriate amount of homework
Express concern for the students and how much they learn
Be available for questions
Lecture and answer students questions effectively

Figure 5. Teaching Objectives for MME105 and MME181

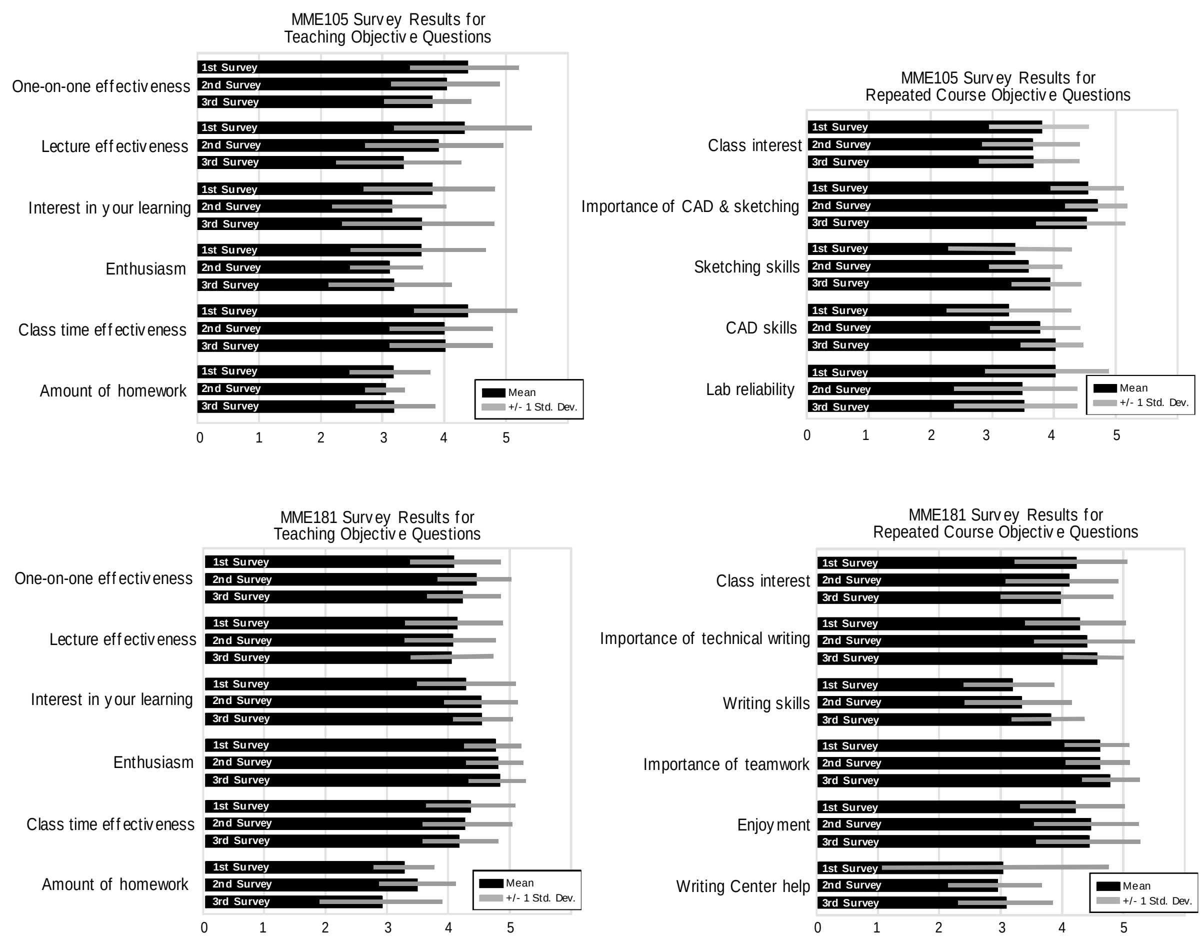

Figure 6. Summary of repeated course and teaching objectives for MME105 and MME181

Table 1. MME 105 Survey questions and results. (Avg = Average, Stdev = Standard deviation)

	1st Survey			2nd Survey			3rd Survey	
	Avg	Stdev		Avg	Stdev		Avg	Stdev
Rate your interest in taking MME105 now.	3.84	1.12		3.63	1.02		3.67	1.19
Rate the Importance of knowing how to create and interpret engineering sketches and drawings.	4.47	0.61		4.69	0.48		4.50	0.71
Rate your sketching skills.	3.30	1.08		3.56	0.63		3.89	0.58
Rate your ability to use CAD to model and convey your ideas.	3.26	0.99		3.75	0.77		4.00	0.59
Rate the reliability of the CAD lab computers.	4.06	0.94		3.38	0.89		3.44	0.78
Rate the effectiveness of the professor in one-on-one situations.	4.32	0.89		4.00	0.82		3.75	0.68
Rate the effectiveness of the professor as a lecturer.	3.89	1.13		3.44	1.15		3.22	0.94
Do you feel the professor is interested in how much you learn?	3.74	1.05		3.13	0.89		3.59	1.23
Rate the enthusiasm of the professor.	3.42	1.07		3.07	0.59		3.12	0.99
Do you feel class time is being used effectively?	4.37	0.83		3.94	0.85		3.94	0.80
Rate the amount of homework. (1= too little, 5= too much)	3.15	0.67		3.00	0.37		3.17	0.62
Rate your interest in taking MME105 at the beginning of the quarter.	3.47	1.26						
Rate the effectiveness of in class projects and lecture examples.	4.33	0.84						
Could you explain the difference between solid modeling and 2D drafting? (1 = can't explain, 5 = can explain completely)	4.21	0.85						
Could you explain what a "folded" view is? (1 = can't explain, 5 = can explain completely)	4.26	0.99						
Rate the usefulness of Wednesday's hands-on CAD projects.				4.25	0.68			
Could you explain the basic rules for dimensioning? (1 = can't explain, 5 = can explain completely)				3.75	0.68			
Could you explain what a section view is used for? (1=can't explain,5=can explain completely)				3.56	0.63			
Rate the usefulness (to date) of the final design project.							3.50	0.92
Could you explain the difference between an engineering drawing and a technical illustration? (1 = can't explain, 5 = can explain completely)							4.06	0.87
Could you explain what an auxiliary view is used for? (1 = can't explain, 5 = can explain completely)							4.33	0.84

Table 2. MME 181 Survey questions and results. (Avg = Average, Stdev = Standard deviation)

	1st Survey			2nd Survey			3rd Survey	
	Avg	Stdev		Avg	Stdev		Avg	Stdev
Rate your interest in taking MME181 now.	4.21	0.91		4.06	0.89		3.95	0.88
Rate the importance of technical writing in engineering practice.	4.34	0.78		4.44	0.70		4.59	0.50
Rate your technical writing skills.	3.24	0.71		3.38	0.85		3.72	0.61
Rate the importance of teamwork in engineering practice.	4.63	0.54		4.64	0.55		4.73	0.45
Do you enjoy working in a team?	4.16	0.79		4.44	0.75		4.41	0.80
Rate the usefulness of the help you got from the Writing Center.	3.00	1.87		2.89	0.78		3.09	0.70
Rate the effectiveness of the professor in one-on-one situations.	4.06	0.78		4.41	0.61		4.22	0.63
Rate the effectiveness of the professor as a lecturer.	4.11	0.80		4.03	0.72		4.00	0.67
Do you feel the professor is interested in how much you learn?	4.34	0.81		4.47	0.61		4.51	0.51
Rate the enthusiasm of the professor.	4.79	0.47		4.82	0.39		4.81	0.40
Do you feel class time is being used effectively?	4.32	0.77		4.26	0.71		4.22	0.58
Rate the amount of homework. (1= too little, 5= too much)	3.37	0.54		3.53	0.61		2.89	0.97
Rate your interest in taking MME181 at the beginning of the quarter.	3.29	1.16						
Rate the usefulness of the Personal Web Site Design class.	3.63	1.15						
Rate the effectiveness of the Personal Web Site Design lecturer.	3.58	1.15						
Could you explain what are design constraints and functional requirements? (1 = can't explain, 5 = can explain completely)	4.03	0.75						
Could you name main steps in the design process? (1 = can't name any, 5 = can name all and know what they are)	3.32	0.71					3.76	0.68
Rate the improvement of your technical writing skills this quarter.				3.44	0.66			
Rate the usefulness of professor's help and comments on your writing.				3.55	0.90		3.68	1.03
During the Personal Web Site Design Class: Rate whether you felt rushed. (1= the class was too slow, 5= the class was too fast)				3.18	1.00			
During the Personal Web Site Design Class: Rate the amount of available help. (1= too little, 5= too much)				3.38	0.89			
Could you explain how a 4-stroke spark-ignition internal-combustion engine works? (1 = can't explain, 5 = can explain completely)				4.24	0.65			
Rate the usefulness of the Tau Beta Pi class.							3.32	1.17
Rate the effectiveness of the Tau Beta Pi facilitator.							3.80	0.90