Two More Ways to Evaluate Teaching Performance

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Introduction

The search continues for effective ways to evaluate college teaching. Still, the most prevalent assessment tool is the student evaluation. The authors examined two additional tools to determine whether they might provide administrators with useful supplementary information for formative and summative evaluations. One is a student assessment of their learning using the course learning objectives, while the other looks at the number of students who drop the course. These tools still use students in the assessment process, but one tries to disassociate learning assessment from instructor personality assessment, and the other is based on student action (dropping the course) and not on student opinion. The investigation revealed that the course learning assessment can be a useful tool for evaluating teaching, but the student drop rate is not.

This paper continues by presenting the current student evaluation of teaching used in the College of Engineering at Michigan State University (MSU). The student self-assessment of course learning objectives is then discussed, including the correlation between the assessment of achieving the course learning objectives and the standard teaching evaluation. This is followed by an examination of the use of student drop rates as a tool to assess teaching. The paper concludes with observations about these assessment tools.

Student Evaluation of Teaching

At the end of each semester, students in the College of Engineering at Michigan State University (MSU) evaluate their teachers by completing the Student Instructional Rating System (SIRS) form, which asks them to respond to the following five questions:

- 1. The instructor was available and willing to help the student.
- 2. The instructor explained course material clearly.
- 3. The instructor was well prepared for classes and other related course activities.
- 4. The instructor organized the course well.
- 5. Rate the instructor on the following scale: 4.0 3.0 2.0 1.0 0.0

For the first four questions students are asked to respond with

Strongly Agree Agree Neither Disagree Nor Agree Disagree Strongly Disagree The university scoring office provides results for the first four questions using a rating scale of 1 to 5, with 1 corresponding to Strongly Agree and 5 corresponding to Strongly Disagree. An overall rating, which is an arithmetic average of the ratings from these first four questions, is also provided. The results for the fifth question are provided on a 4.0 scale, consistent with the grading scale at MSU.

For the purpose of this study, the overall rating and the 4.0 scale rating were plotted against each other, as shown in Figure 1. Since the two ratings are very well correlated, it would appear that either rating would appropriately portray the student assessment of teaching. Although the Department of Mechanical Engineering uses the overall rating in its merit pay formula, the authors decided to use the 4.0 rating scale in this paper, due primarily to its consistency with a typical grading system.

Course Learning Objectives

As part of the its response to Engineering Criteria 2000, each undergraduate course in the Department of Mechanical Engineering has a published a set of course learning objectives (CLO). At the end of each semester, students complete a course learning objective questionnaire in addition to the university's SIRS form. It is important to note that the course learning objectives, but that this may not be a true indication of their achievement. Two examples of these questionnaires are shown in Figures 2 and 3. As is seen, both the number of questions and the type of questions can vary significantly from course to course. Due to the lack of department control, the university scoring office reverses the 5 to 1 scale on the questionnaire to a 1 to 5 scale (consistent with the overall scale from the SIRS form).

An arithmetic average was calculated for the course learning objective evaluation results for each course, and is used to represent the students' overall perception of their learning. In Figure 4 this average (called the learning assessment rating) for each required mechanical engineering course is plotted against the teaching evaluation rating for the course represented by the 4.0 scale rating. In general, we see an excellent relationship between the learning assessment and the teaching evaluation. That is, for highly rated instructors (those with teaching evaluation ratings close to 4.0) students indicate a high level of confidence in achieving the course learning objectives (learning assessment ratings close to 1.0), while for instructors with low ratings, students indicate a low level of confidence. There are a few cases that do not follow this trend, in particular the two data points that lie around a teaching evaluation rating of 2.85 and a learning assessment rating of 1.65. These data points are for the same faculty member teaching the same course. This instructor does have an abrasive personality and the low teaching evaluation rating is probably due more to a personality mismatch between the faculty and students than to poor teaching. The strong learning assessment rating would indicate that effective teaching has taken place in these classes.

The overall trend in the data would suggest two observations. First, there appears to be a significant increase in the learning assessment rating at the higher end of the teaching evaluation rating. That is, students perceive that their learning is enhanced considerably, when one considers a master teacher (indicated by the near 4.0 teaching evaluation rating) versus a very



Figure 1. Correlation between the Two Teaching Evaluation Scales

Figure 2. Course Learning Objective Questionnaire for Thermodynamics

ME 2000

The Mechanical Engineering Undergraduate CQI Program at Michigan State University

Supplemental SIRS Questions: ME 201

Using the bubbles available under the Supplemental Question portion of the SIRS form, evaluate your level of confidence with the following topics. Please use a 5-1 scale with 5 indicating complete confidence and 1 indicating no confidence. Since there are no numbers under the bubbles on the SIRS form, please treat the first bubble for a question as the 5 and the last bubble as the 1 as shown below



- A. Ability to identify control volumes, closed systems, and transient systems
- B. Ability to apply the state principle
- C. Ability to recognize three types of substances: ideal gas, compressible substance, incompressible substance
- D. Ability to use tables to evaluate the properties of compressible substances, including identifying the phase of the substance
- E. Ability to use tables to evaluate the properties of ideal gases
- F. Ability to use equations to evaluate the properties of incompressible substances
- G. Ability to calculate boundary work for a system from JPdV
- H. Ability to apply the first law to closed systems
- I. Ability to apply the first law to control volume systems
- J. Ability to apply the first law to transient systems
- K. Ability to calculate the thermal efficiency for a heat engine and the coefficient of performance for a refrigerator and heat pump
- L. Understanding the Clasius statement and the Kelvin-Planck statement of the second law
- M. Understanding the concept of reversibility
- N. Ability to understand the principle of the Carnot cycle and make calculations of Carnot thermal efficiency and Carnot coefficient of performance
- O. Ability to understand the entropy property and can evaluate it for different types of substances
- P. Ability to calculate and interpret the entropy change of the universe for a process
- Q. Ability to use isentropic efficiencies for control volume work devices
- R. Ability to solve and analyze engineering problems by applying appropriate combinations of thermodynamic principles and knowledge of fluid properties

Figure 3. Course Learning Objective Questionnaire for Mechanical Design II

ME 2000

The Mechanical Engineering Undergraduate CQI Program at Michigan State University

Supplemental SIRS Questions: ME 471

Using the bubbles available under the Supplemental Question portion of the SIRS form, evaluate your level of confidence with the following topics. Please use a 5-1 scale with 5 indicating complete confidence and 1 indicating no confidence. Since there are no numbers under the bubbles on the SIRS form, please treat the first bubble for a question as the 5 and the last bubble as the 1 as shown below



- A. Understanding of engineering design as a process
- B. Understanding of the steps involved in the development of a product
- C. Ability to use methods for solving open-ended problems
- D. Understanding of design-for-assembly and design-for-manufacture protocols
- E. Ability to use basic failure theories relevant to machine component design in presentations and case studies
- F. Operational knowledge of modern computer-based techniques for computer assisted design, including methods for finite element analysis and design optimization
- G. Ability to work in teams to design, build and test a product and, through this experience, to develop problem solving, time management, organization, and team participation skills





good teacher (probably somewhere in the range of 3.5 to 3.75 for a teaching evaluation rating). For example, a 7% increase in teaching evaluation rating at the upper end translates to a 41% increase in learning assessment rating. This trend might suggest that the teaching efficiency model presented in Wankat and Oreovicz [1] does not apply to the enhanced learning students experience from a master teacher. The second observation deals with data at the lower end of the teaching evaluation rating, where one could argue a plateau is reached. For the range of teaching evaluation rating from 3.0 to 1.0, only a 13% drop in the learning assessment rating is noted. One might assume that for a teaching evaluation rating below 3.0, the instruction is sufficiently poor that students are learning the material on their own, and hence the quality of teaching is less important to the learning experience.

To investigate other trends, the learning assessment ratings were plotted against the teaching evaluation rating for specific groups of courses. The only service course taught in the department is thermodynamics, ME 201. In Figure 5 we see that there is a similar relationship as that for all required mechanical engineering courses, including the trends noted at both the higher end and lower end of the teaching evaluation rating scale. The learning assessment rating data for junior level courses in mechanical engineering are presented in Figure 6. Again the trends are consistent, though it should be noted that the two courses represented by the data points at the upper end of the ratings are project intensive courses, which have been recognized as being more effective for learning than non-project courses [2]. In fact, in Figure 7 the project courses are identified separately from courses that include laboratories or the lectured based engineering science courses. As one might expect from the literature [3,4,5], the learning assessment rating is nearly always better for a project-oriented course versus a non-project course for the same teaching evaluation rating. This gives some credence to the learning assessment rating as an indication of student learning. The authors are somewhat surprised that a similar observation cannot be made in comparing the courses that include laboratory experiences to the lecture based engineering science courses.

Student Drop Rate

One piece of data that is often available to administrators is the number or percentage of students who have dropped the course. We know that students drop classes for a variety of reasons, but quite often they do so because they perceive poor teaching. This study examined the final drop rate in relationship to the instructor's 4.0 scale rating for three groups of courses, for which there was sufficient data, to determine whether there might a relationship between the two numbers. The drop rate was obtained by dividing the number of students enrolled in the last day of class by the number enrolled on the first day. The three groups of courses, and all technical elective courses.

Figures 8 and 9 appear to indicate little or no relationship between the drop rate and the teaching evaluation rating. In order to confirm this, Spearman's ρ correlations were calculated for three groups of courses with the following results (Spearman's ρ was selected because the student rating of instructors was on a 4-point ordinal scale):



Figure 5. Correlation of Learning Assessment with Teaching Evaluation for ME 201 (Thermodynamics)



Figure 6. Correlation of Learning Assessment with Teaching Evaluation for Junior Level Mechanical Engineering Courses.



Figure 7. Correlation of Learning Assessment with Teaching Evaluation for Different Instructional Models.



Figure 8. Correlation of Final Drop Rate with the Teaching Evaluation Rating (4.0 Scale) for all Mechanical Engineering Courses.



Figure 9. Correlation of Final Drop Rate with the Teaching Evaluation Rating (4.0 Scale) for Senior Technical Elective Courses.

All Mechanical Engineering Courses (N=34): $\rho = -.164$, p = .444All Required Mechanical Engineering Courses (N=24): $\rho = -.144$, p = .692All Technical Elective Courses (N=10): $\rho = -442$, p = .200

where ρ refers to the Spearman's ρ correlation, and *p* is the level of statistical significance. In all cases, given levels of significance exceeding .05, Spearman ρ correlation is not statistically significant.

Conclusions

It appears that one of the two assessment tools, a student learning assessment survey, can offer administrators further insight into teaching performance. In particular:

- There is a strong relationship between the results of the student learning assessment survey and the teaching evaluation for the course. Instructors that receive strong teaching evaluation ratings generally receive strong learning assessment ratings
- Anomalies in the trend noted above may well be due to personality issues between instructor and students, indicating that students can separate their personal feelings for an instructor when completing a learning assessment.
- Extraordinarily strong teaching evaluations (indicating a master teacher level of instruction) give rise to an exceptional increase in the learning assessment rating.
- Once the teaching evaluation rating drops below a threshold, the learning assessment rating changes very little.
- Project based course receive better learning assessment ratings, providing some evidence for the use of these ratings in assessing student learning.

Unfortunately, however, the student drop rate is neither practically useful nor statistically significant, probably because of the lack of flexibility in the mechanical engineering program. Specifically:

- The program consists of tightly knit and closely monitored chains of prerequisites that make it difficult for students to postpone their courses.
- Only 1 –2 sections of each course are offered each semester. Since the number of available seats is approximately equal to the number of students who need to enroll, students have limited choices when constructing their schedules.
- Even when there is an opening, students have a tendency to resist changing their schedule when the open course or section is offered at an undesirable time.

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