Using Large-Scale Student Ratings of Instruction To Improve Formative Evaluation of College Teaching

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Abstract

Using Bayesian Model Averaging, we analyzed course-level student ratings of instruction (SRI) data collected in undergraduate and graduate classes (N = 6,405) from 27 institutions, representing all regions of the continental U.S.. Distinctive patterns of teaching methods emerged as significant predictors for student progress on each relevant learning objective.

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Research on student ratings of instruction (aka, student evaluation of teaching) goes back nearly 100 years to when E. T. Guthrie first used them in the 1920s at the University of Washington, although their widespread use did not occur in North America until the 1960s or early 1970s (Murray, 2005). Since that time, they have been one of the most widely studied topics in higher education due to their ubiquitous role in teaching evaluations and the prevalence of large datasets of student ratings available on most college campuses (Benton & Cashin, 2014). Although using student ratings of instruction (SRI) for evaluation is common practice, they are nonetheless rife with controversy. The dispute most likely stems from their over-emphasis in summative decisions about teaching effectiveness and their under-utilization in formative evaluations (Pallett, 2006). The purpose of this paper is to report how student ratings can provide instructors with specific formative feedback—apart from summative information—about how to improve their teaching.

But Can Students Really Provide Useful Feedback?

Opponents of student ratings argue that students are not competent to judge teaching effectiveness and, therefore, offer little insight into how instructors might improve (Stark & Freishtat, 2014; Uttl, White, & Gonzalez, n.d.; Wieman, 2015). Others disagree, countering that students spend more time than anyone else interacting with the instructor and observing teacher behaviors (Arreola, 2006; Benton & Cashin, 2014; Svinicki & McKeachie, 2014; Theall & Franklin, 2001). Students can, for example, accurately judge how much progress they have made on key learning objectives (Benton, Duchon, & Pallett, 2013). They can also reliably report how frequently the instructor engaged in specific teaching behaviors, perceptions of course difficulty,

overall impressions of the teacher and the course, and their motivation to take the course (Benton, Li, Brown, Guo, & Sullivan, 2015; Theall & Franklin, 2001). In fact, student ratings are the most reliable source of information about what actually occurs in the classroom, because they represent the perceptions of multiple raters across multiple occasions. In contrast, peer and administrator observations typically take place only once or twice in a semester.

Nonetheless, some faculty may hesitate to consider students qualified to offer discriminating feedback about teacher behaviors. How can students offer credible information when most of them have never taught? An analogy from the medical profession may help. Hospital administrators typically evaluate physicians' effectiveness by collecting survey data from patients who give valuable feedback about quality of care. Patients can offer opinions about their experiences interacting with the physician, perceived progress made during recovery, quality of care, and so forth (Manary, Boulding, Staelin, & Glickman, 2013). Even though most patients have never been doctors, ignoring their judgments would be foolish. Hospital administrators would lose helpful information about how to improve patient services just as academic administrators would lose valuable information about how to improve teaching if they ignored the student voice. However, both would be equally unwise to render decisions about physician/teacher effectiveness, respectively, based solely on patient/student input. Hence, students should be one of several sources of evidence considered when evaluating teaching effectiveness (Hoyt & Pallett, 1999). When the combined data are in agreement, reliability increases (Cashin, 1996).

Additional evidence supports the view that students are indeed qualified to provide valid feedback. Student ratings correlate positively with ratings by colleagues, alumni, trained observers, and administrators (Feldman, 1989). Moreover, student ratings of progress on relevant

course objectives are positively correlated with exam performance (Benton et al., 2013). So, rather than arguing over whether students are competent to rate, faculty should devote time and resources to constructing good questions for students to answer (Benton & Ryalls, 2016). As Manary and colleagues (Manary et al., 2013) state in the area of patient health care, so the same can be said in the area of student ratings of instruction: "When designed and administered appropriately,…surveys provide robust measures of quality" (p. 201).

Usefulness of SRI in Formative Evaluation of Teaching

Although outcries about purported bias in student ratings have dominated the literature since their inception (see literature reviews by Benton & Cashin, 2014; Marsh, 2007; McKeachie, 1997; Theall & Franklin, 2001), poor practice—more than anything else—has probably led to greater inappropriate use of ratings (Hativa, 2014). Administrators misuse ratings, for example, when they make ratings the only source of evidence for evaluating teaching effectiveness, make decisions about a faculty member based on data from a single class, make too much of too little by overemphasizing small differences in average scores, ignore comparative scores, put too much weight on student written comments, and neglect to respond to negative student feedback about a faculty member. Faculty, in turn, misapply SRI when they fail to adhere to standard survey administration procedures, grade leniently in the false hope of obtaining higher ratings, modify the course or teaching approaches to appease student complaints, and denigrate ratings as having no value whatsoever (Hativa, 2014).

But, perhaps the greatest negligence comes from ignoring the student voice as a valid source of formative evaluation of teaching. In spite of faculty skepticism about the value of student ratings (e.g., Campbell & Bozeman, 2007), when used appropriately they can have a

positive impact provided the instrument asks the right questions (Benton & Ryalls, 2016). The key is what the instructors do with the feedback they receive.

Effective use of student feedback begins with self-reflection, which goes beyond simply looking at the ratings without giving much thought to them. Instructors need to take time to understand what students are saying and to interpret that information in reference to their own experiences teaching the course. However, feedback that differs from the teacher's view of how things went in the classroom may create disequilibrium or cognitive dissonance, which can either bring on defiance or the need to resolve the disagreement (Kember, McKay, Sinclair, & Wong, 2008).

Although faculty can initiate self-reflection based simply on the feedback they infer from student ratings, the greatest gains are found when teachers consult with a knowledgeable other (Brinko, 1990; Cohen, 1980; Hampton & Reiser, 2004; Hativa, 2014; Knol, 2013; Marincovich, 1999; Marsh, 2007; Marsh & Roche, 1993; Ory & Ryan, 2001; Penny & Coe, 2016). The utility of ratings is especially evident when conversations address problems students have identified, such as grading practices, overall ratings of the instructor or course, exam difficulty, textbook selection, and so forth (Schmelkin, Spencer, & Gellman, 1997). Moreover, instructors can make meaningful improvement with small, intentional efforts. They can, for instance, create opportunities for active learning in the classroom, interact directly with students (e.g., get to know their names), set expectations and maintain high standards, be well-prepared for class, and revise assessment methods (Benton, Guo, Li, & Gross, 2013b; McGowan & Graham, 2009).

Purpose of the Study

An assumption of the IDEA SRI system is that student ratings of the frequency of teaching methods exhibited by the instructor are differentially related to student self-reported

ratings of progress on course-relevant learning objectives. For example, whereas “made it clear how each topic fit into the course” is an important method for making progress on “gaining a basic understanding of the subject” and “developing specific skills,” it is relatively ineffective in “acquiring skills in working with others as a member of a team” or “developing creative capacities.” In contrast, students make greater progress on *team skills* and *creative capacities* when the instructor inspires them to “set and achieve goals which really challenged them.” The question addressed in this study, then, was the following:

RQ: *Which teaching methods are most strongly related to student ratings of progress on learning objectives identified as relevant to the course*?

The end goal of the analysis was to identify items to include in the revised IDEA SRI system. The previous revision, completed in 1999, resulted in a 47-item instrument with which students rated the frequency of 20 teaching methods and their self-reported progress on 12 learning objectives. Other items pertained to student and course characteristics along with two single-item ratings of the teacher and course. The analyses described here were performed on data collected in the Spring 2015 pilot of new items on IDEA’s new platform powered by Campus Labs.

Method

Instrumentation

The IDEA SRI is a two-form system. Faculty complete the *Objective Selection Form* (OSF) by indicating the relevance of 12 learning objectives for their course, using a 3-point scale (M = *Minor or No Importance*, I = *Important*, and E = *Essential*, coded as 1, 2, and 3 respectively). In the Spring 2015 pilot, instructors responded online to the 12 existing objectives on the IDEA system along with 5 proposed learning objectives. The proposed objectives were

developed via focus groups comprised of faculty and students as well as subject-matter experts (Benton et al., 2015).

Students completed the 47-item *Diagnostic Feedback* form by responding to corresponding 5-point scales. In the Spring 2015 pilot, students reported how frequently they perceived their instructor used each of the 20 existing along with four additional proposed teaching methods, using the scale of 1 = *Hardly Ever*, 2 = *Occasionally*, 3 = *Sometimes*, 4 = *Frequently*, and 5 = *Almost Always*. Students also reported their self-perceived progress made on each of the same learning objectives their instructor rated on the OSF, responding 1 = *No apparent progress*; 2 = *Slight progress; I made small gains on this objective*; 3 = *Moderate progress; I made some gains on this objective*; 4 = *Substantial progress; I made large gains on this objective*; 5 = *Exceptional progress; I made outstanding gains on this objective*. The five proposed objectives and four proposed teaching methods were presented at the end of the survey, using the numbering sequence 49 through 58. Students also responded to several course and student characteristics along with two overall summary measures, none of which are relevant to the current study. Table 2 presents wordings for the all existing and proposed learning objectives and teaching methods retained in the revised IDEA SRI system.

Sample

In the spring of 2015, 49,803 undergraduate and graduate students completed 128,600 surveys in 14,521 classes on the IDEA SRI platform powered by Campus Labs. We excluded classes that had a survey start date that preceded the pilot (n = 2,364), where the instructor identified no existing objective as Essential or Important (n = 3,045), and those with fewer than five student responses (n = 2,707). As a result, 6,405 classes from 27 institutions, representing all regions of the continental U.S., were included in the pilot sample. Table 1 presents a breakdown

of institutions in the pilot sample, based on their accreditation regions by Carnegie classification and by institutional control (public vs. private).

Data Analysis

We employed Bayesian Model Averaging (BMA), an ensemble technique for testing multiple regression models, to arrive at a better prediction than what would be obtained from a single regression analysis (Hoeting, Madigan, Raftery, & Volinsky, 1999). The purpose was to derive at estimated probabilities that student ratings on each teaching method are related to progress ratings on each learning objective. The Schwartz Bayesian Criterion (SBC) was applied to select the best 100 models among a finite set of models (2 to the *k*th power, where *k* is the number of explanatory variables). We conducted separate analyses on each learning objective, including only classes where the instructor identified the objective as either Essential or Important for the course. The dependent variable in each analysis was the course-level average (i.e., mean) student progress rating on the relevant learning objective. Explanatory variables were course averages on frequency of each of the 20 existing and four proposed teaching methods.

The efficacy of IDEA teaching methods varies by class size and student self-reported desire to take the course, i.e., motivation (Benton et al., 2015; Hoyt & Lee, 2002). In general, students report greater instructor use of the teaching methods in smaller classes and in classes where the average student motivation is high. We, therefore, began by breaking classes into small (10 to 14 students), medium (15 to 34), large (35 to 49), and very large (50 or greater) categories. However, insufficient numbers were available to fill all class size/motivation groupings. Consequently, we conducted the analyses using only medium-size classes (N = 2,099) with no demarcation by student motivation. We will expand the analyses to include small, large, and very large classes by motivation levels as more data are collected.

Results and Discussion

Tables of estimated probabilities and regression parameters (weighted coefficients) are presented for each learning objective in Appendix A. Table 2 summarizes the significant explanatory variables (indicated by item number on the pilot instrument) included in the best full models for each of the 13 learning objectives retained in the revised IDEA SRI. The learning objectives in Table 2 are partitioned into four dimensions as determined previously by factor analysis of faculty ratings of relevance to the course (Li, Benton, Brown, Sullivan, & Ryalls, 2016): general life skills, professional skills, cultural/creative development, and course-specific skills. As we expected, the efficacy of each teaching method varied by which learning objective the instructor emphasized. In the following paragraphs we discuss the teaching methods most highly correlated with student self-reported progress on learning objectives within each dimension.

General Life Skills

General life skills include oral and written communication, critical thinking, global awareness, ethical reasoning/decision making, and civic engagement. Three teaching methods were strongly correlated with at least two learning outcomes connected to general life skills: "helped students to interpret subject matter from diverse perspectives," "related course material to real life situations," and "created opportunities to apply course content outside the classroom."

Helped students to interpret subject matter from diverse perspectives. Understanding diverse perspectives is, according to the U.S. Department of Education, an essential 21st Century skill (Fischer, 2012). Other educational organizations agree. The Association of American Colleges and Universities encourages instruction "anchored through active involvement with diverse communities" (The Association of American Colleges and Universities, n.d.). Consistent

with this view, the Higher Learning Commission recommends that “the education offered by the institution recognizes the human and cultural diversity of the world in which students live and work” (The Higher Learning Commission, n.d.).

The results of this study show teaching methods that help students acquire such diverse perspectives are highly correlated with student self-reported progress on general life skills. Although the manner in which instructors accomplish this is not revealed by our analysis, other research offers suggestions.

In this study, students who reported more frequent instructor help in developing diverse perspectives also reported greater progress on all of general life skills. One such skill was communication, which involves “social and collaborative processes” that can expose students to diverse views (Johnson, 2006). To facilitate such processes, instructors might help students understand others’ viewpoints by asking them to share their writing with a peer, a method shown to improve writing skills (Benton & Martin, 2004; Davis, 2009; Johnson, 2006). Fostering diverse perspectives was also associated with greater student progress on critical thinking skills, which is consistent with the finding that students who have more experience with diversity, especially courses on diversity and positive relationships with diverse peers, also score higher on critical thinking disposition (Laird, 2005). Greater gains were also reported in global awareness, which supports the connection between exposure to diverse perspectives and understanding of globalization issues (Mwebi & Brigham, 2009). In addition, diverse perspectives were positively correlated with student progress on ethical reasoning/decision making. Others have likewise found that students who are exposed to diverse viewpoints exhibit greater commitment to ethical decision making (Bentley-Williams & Morgan, 2013). Finally, exposure to diversity also was

associated with greater student self-reported gains in civic engagement, which is in line with previous findings (Castellanos & Cole, 2015).

Related course material to real life situations. The teaching method of relating course material to real life situations was strongly related to student self-reported progress on ethical reasoning/ethical decision making, which supports previous findings based on a meta-analysis of 26 evaluations of ethics academic programs (Antes et al., 2009). Antes et al. (2009) found that courses focusing on problems encountered in real-world settings were more effective in enhancing student ethical behavior outcomes than those addressing limited academic skills specific to a particular domain. In the current study, real-world applications also led to greater student progress on civic engagement. This is not surprising because, by its very nature, civic engagement involves application of course content to real-world contexts (Maddrell, 2014).

Created opportunities to apply course content outside the classroom. Students who reported frequent opportunities to apply course content outside the classroom also perceived greater progress on civic engagement and information literacy. That civic engagement was positively correlated with applications outside the classroom follows from Maddrell's (2014) work cited previously. Civic engagement and activities conducted outside of class typically go hand in hand. The connection between application of content beyond the classroom and information literacy is buttressed by findings regarding situated learning, i.e., learning content within the context in which it will be used. Specifically, when instructors teaching information literacy require students to evaluate the veracity of information in situations outside the classroom, students are more likely to transfer that knowledge and skill to real-world contexts (Catalano, 2015).

Professional Skills

Professional skills pertain to applications of course material; specific skills, competencies, and viewpoints; and team skills. In this study, three teaching methods were strongly related to at least two of these professional skills: “inspired students to set and achieve goals which really challenged them,” “stimulated student to intellectual effort beyond that required by most courses,” and “demonstrated the importance and significance of the subject matter.”

Inspired students to set and achieve challenging goals. When instructors encourage students to set and achieve goals that challenge them they are encouraging a *mastery goal orientation* (Elliot & Harackiewicz, 1996; Svinicki & McKeachie, 2014). Students focus on their own improvement rather than on comparing their progress to others. They try to learn as much as they can, take risks, and to not worry about making mistakes. Their effort is directed toward pursuit of the challenges their instructor places before them. The reason the pursuit of challenging goals is connected to professional skills is because:

> …skill type objectives such as those addressing problem solving, professional skills, [and] teaming…should focus on personal improvement rather than comparison with others. Having students reflect on how much they’ve developed since their previous use of the skill and how they were able to improve will encourage a mastery orientation. (ref, p. ???)

Stimulated intellectual effort. Two learning outcomes were associated with stimulating intellectual effort: applications of course material; and specific skills, competencies, and viewpoints. Although instructors employ various strategies for getting students excited about learning, catching students’ attention is one way that has been shown to stimulate intellectual effort or motivation (Hidi, 1990). Instructors generally do this in one of two ways: by creating

situational interest or by tapping into students' *individual interests*. Both approaches strengthen students' cognitive and affective functioning (Hidi, 1990). To direct student attention to a situation, instructional materials and classroom activities must first be interesting enough. Such situational interest emerges from learners' cognitive and affective reactions to environmental cues they find stimulating (Hidi & Baird, 1986). Individual interest, on the other hand, is a durable characteristic associated with preferences for certain content or tasks connected to what students already know and value. Both situational and individual interest stimulate student intellectual effort and influence attention, goals, and learning (Hidi & Renninger, 2006).

In the current study, stimulating students' intellectual effort was associated with greater student self-reported progress on applications of course material to improve thinking, problem solving, and decisions; and development of professional skills, competencies, and viewpoints. Returning to the construct of situational interest, researchers have found that it influences cognitive performance in reading (Hidi, 1990) and writing (Benton, Corkill, Sharp, Downey, & Khramtsova, 1995), which are instances of academic problem solving. Having interest in a situation also focuses attention (Hidi, 1995) and helps students integrate new information with stored knowledge (Kintsch, 1980), which can facilitate problem solving (Bruning, Schraw, Norby, & Ronning, 2004). Individual interest, in turn, positively impacts persistence and effort (Renninger & Hidi, 2002), academic motivation (Harackiewicz & Durik, 2003), and general cognitive performance (Krapp, 2002), constructs associated with the development of skills and competencies.

Demonstrated importance and significance of the subject matter. Students who observed more frequent instructor use of this teaching method also reported greater progress on applications of course material and development of professional skills, competencies, and

viewpoints. One explanation for the connection might again be the construct of interest. When teachers demonstrate the significance of content they probably stimulate student interest by relating course material to real-world situations and by involving students in creative applications (McClure & Theall, n.d.). Showing how subject matter is relevant to students' lives increases their focus (Hidi, 1995) and motivation (Harackiewicz & Durik, 2003).

Cultural/creative Development

Another type of learning objective is cultural/creative development, which concerns growth in creative capacities and acquisition of a broad liberal education. The single method most highly correlated with student progress in this dimension of learning was "inspired students to set and achieve goals which really challenged them." Inspiring and challenging students was positively correlated with greater creativity in writing, inventing, designing, and performing in arts. This finding is consistent with evidence that learning (i.e., mastery) goals can lead students to create novel and useful products by increasing cognitive flexibility (Miron-Spektor & Beenen, 2015). Inspiring students to set and achieve challenging goals was also associated with greater self-reported progress in appreciating intellectual/cultural activity. An explanation for this finding comes from the field of neuroscience: Inspiration engages not only higher cortical circuitry but also the limbic system and medial front structures, which facilitate appreciation of aesthetics (Tyler & Likova, 2012).

Course-specific Skills

Course-specific skills, another dimension of learning objectives, includes "collecting, analyzing, and interpreting numerical information" (i.e., quantitative reasoning) and "gaining a basic understanding of the subject." Students reported greater progress on quantitative reasoning when instructors encouraged "student-faculty interaction outside of class." This is in line with

the finding that college students who report positive and helpful relationships with their teacher also report greater learning and motivation; whereas students who experience the opposite report decreases in learning and motivation (Docan-Morgan & Manusov, 2009). Moreover, students who have positive statistics self-efficacy, which is developed from a positive emotional bond with the instructor, also have higher achievement in statistics (Waples, 2016).

Although only one method was associated with progress on quantitative reasoning, three were highly correlated with gaining a basic understanding of the subject. The first, "introduced stimulating ideas about the subject" supports what has already been stated previously in this paper about the benefits of stimulating student interest. But, in this case, the key variable is probably *topic interest*, which is "a deep personal interest in a field or activity based on pre-existing knowledge, personal experiences, and emotions" (Flowerday & Shell, 2015). Topic interest helps to explain, for instance, individual differences in mind wandering during reading, which affects comprehension (i.e., understanding). Students who have greater interest in the topic are less likely to be distracted during reading (Unsworth & McMillan, 2013). Topic interest is also positively correlated with recall and accuracy of answers to comprehension questions (Clinton & van den Broek, 2012). The second teaching method highly correlated with understanding the subject was "encouraged students to reflect on and evaluate what they have learned" (i.e., self-reflection). Self-reflection requires self-assessment and adaptation to performance outcomes (Zimmerman, Moylan, Hudesman, White, & Flugman, 2011). In a sense, "what did I do well, what did I do poorly, and how can I improve"? Students who participate in self-reflection training outperform those who do not on instructor-developed examinations; they are more successful at regulating their self-efficacy beliefs before problem solving and their self-evaluative judgments after problem solving (Zimmerman et al., 2011). The third method

associated with understanding the subject was “made it clear how each topic fit into the course.” This method aids understanding because it helps students not only identify the key concepts and principles and their interrelationships but also their connections to broader ideas (Johnson, 2006). Another reason why topic clarification enhances understanding is because it provides a structure and helps students construct new knowledge by attaching the key topics to prior learning (Zull, 2012).

Limitations of this Study

We should mention several limitations of the study. First, classes were not randomly selected, and, therefore, results cannot be statistically generalized to all types of institutions and academic disciplines. However, the sample was large and represented all major Carnegie classifications, accrediting regions, and public and private institutions. Second, piloted items appeared at the end of the survey, which can increase the likelihood of non-completion. However, the completion rate for all individual items on the IDEA SRI delivered by Campus Lab is 99% (Li & Benton, 2017). Third, the correlational methods used in this study preclude implications of cause-effect relationships between the instructor’s teaching methods and student progress on relevant objectives. Nonetheless, the BMA approach taken in this study, which averaged across the 100 best models, provides better predictive ability than the traditional approach of using a single model.

Implications

Distinctive patterns of teaching methods are significant predictors of student self-reported progress on each relevant learning objective. Three methods, for example, coincide with greater student self-reported progress on general life skills: helping students interpret subject matter from diverse perspectives, relating course material to real-life situations, and creating

opportunities to apply course content outside the classroom. When teaching professional skills, on the other hand, three different methods stand out: inspiring students to set and achieve challenging goals, stimulating students to intellectual effort, and demonstrating the importance and significance of the subject matter. For instructors selecting cultural and creative development objectives, one method is prominent: inspiring students to set and achieve challenging goals. Finally, for course-specific skills student-faculty interaction outside of class is important when teaching quantitative skills; if helping students simply gain an understanding of the subject, then three strategies are most strongly associated with student progress ratings: introducing stimulating ideas about the subject, encouraging student self-reflection, and making it clear how each topic fits into the course.

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Table 1

*Frequency of Levels of Carnegie Classification and Institutional Control by Regional Location for Pilot Sample Institutions (*N = *27)*

	Carnegie classification				Institutional control	
Regional location	Associate	Baccalaureate	Masters	Doctoral	Private	Public
Middle states	0	1	3	0	0	4
New England	0	0	1	0	0	1
North central	2	6	3	1	4	8
Northwest	0	1	0	0	0	1
Southern	1	3	3	1	4	4
Western	0	0	1	0	0	1

Teaching

Table 2

Teaching Methods Significantly Related with Progress on Relevant Learning Objectives in Medium-Sized Classes (15 – 34 Students)

Learning objective	Relevant teaching methods
23. Learning to apply course material (to improve thinking, problem solving, and decisions)	8 (4, 11, 12, 15, 56)
24. Developing specific skills, competencies, and points of view needed by professionals in the field most closely related to this course	4, 6 (8, 14, 15, 18, 57)
25. Acquiring skills in working with others as a member of a team	5, 15 (14, 55)
26. Developing creative capacities (writing, inventing, designing, performing in art, music, drama, etc.)	15, 19
27. Gaining a broader understanding and appreciation of intellectual/cultural activity (music, science, literature, etc.)	13, 15, 55
28. Developing skill in expressing myself orally or in writing	15, 19, 55, 58 (9)
31. Learning to analyze and critically evaluate ideas, arguments, and points of view	8, 56 (13, 19, 55)
49. Developing knowledge and understanding of diverse perspectives, global awareness, or other cultures	55
50. Developing ethical reasoning and/or ethical decision making	8, 11, 55
51. Learning to apply knowledge and skills to benefit others or serve the public good	11, 55, 56, 57
52. Learning appropriate methods for collecting, analyzing, and interpreting numerical information	20
53. Learning how to find, evaluate, and use resources to explore a topic in depth	9, 15, 57, 58
54. Gaining a basic understanding of the subject (e.g., factual knowledge, methods, principles, generalizations, theories)	6, 8, 13, 56, 57

Note. Item numbers within parentheses had standardized regression coefficients $\geq$ .05 and < .10. Those outside parentheses had coefficients $\geq$ .10.

Teaching Method

3. Scheduled course work (class activities, tests, projects) in ways which encouraged students to stay up-to-date in their work
4. Demonstrated the importance and significance of the subject matter
5. Formed “teams” or “discussion groups” to facilitate learning
6. Made it clear how each topic fit into the course
8. Stimulated students to intellectual effort beyond that required by most courses
9. Encouraged students to use multiple resources (e.g., data banks, library holdings, outside experts) to improve understanding
11. Related course material to real life situations
12. Gave tests, projects, etc. that covered the most important points of the course
13. Introduced stimulating ideas about the subject
14. Involved students in “hands on” projects such as research, case studies, or “real life” activities
15. Inspired students to set and achieve goals which really challenged them
18. Asked students to help each other understand ideas or concepts
19. Gave projects, tests, or assignments that required original or creative thinking
20. Encouraged student-faculty interaction outside of class (office visits, phone calls, email, etc.)
55. Helped students to interpret subject matter from diverse perspectives (e.g., different cultures, religions, genders, political views)
56. Encouraged students to reflect on and evaluate what they have learned
57. Created opportunities for students to apply course content outside the classroom
58. Provided meaningful feedback on students' academic performance

Appendix A: Bayesian Model Averaging on 13 Learning Objectives in Medium Classes (15-34)

Objective 3: Learning to *apply* course material (to improve thinking, problem solving, and decisions)

Model	Size	R^2	TM1	TM2	TM3	TM4	TM5	TM6	TM8	TM9	TM10	TM11	TM12	TM13	TM14	TM15	TM16	TM18	TM19	TM20	TM55	TM56	TM57	TM58
Full		.85				.08			.10			.07	.06			.07						.05	.05	
2 vars		.81				.24										.21								
3 vars		.82							.22			.13										.12		
4 vars		.83							.17			.11	.08									.11		
5 vars		.84							.12			.10	.08			.10						.09		
6 vars		.85				.07			.10			.08	.06			.09						.08		
7 vars		.85				.08			.10			.07	.06			.07						.05	.05	

Objective 4: Developing specific skills, competencies, and points of view needed by professionals in the field most closely related to this course

Model	Size	R^2	TM1	TM2	TM3	TM4	TM5	TM6	TM8	TM9	TM10	TM11	TM12	TM13	TM14	TM15	TM16	TM18	TM19	TM20	TM55	TM56	TM57	TM58
Full		.82	-.05			.12	-.08	.11	.09	-.06					.08	.07		.07					.09	
2 vars		.78						.21								.21								
3 vars		.80						.19								.14							.11	
4 vars		.80				.10		.12								.12							.10	
5 vars		.81				.09		.11	.06							.09							.10	
6 vars		.81				.09		.11	.08	-.05						.10							.12	
7 vars		.81				.10	-.08	.10	.09						.08			.07					.09	
8 vars		.82				.10	-.07	.10	.11	-.05					.09			.07					.10	

Objective 5: Acquiring skills in working with others as a member of a team

Model	Size	R^2	TM1	TM2	TM3	TM4	TM5	TM6	TM8	TM9	TM10	TM11	TM12	TM13	TM14	TM15	TM16	TM18	TM19	TM20	TM55	TM56	TM57	TM58
Full		.72					.16								.08	.18					.06			
2 vars		.70					.18									.26								
3 vars		.71					.17								.07	.22								
4 vars		.72					.16								.08	.18					.06			

Objective 6: Developing creative capacities (writing, inventing, designing, performing in art, music, drama, etc.)

Model	Size	R^2	TM1	TM2	TM3	TM4	TM5	TM6	TM8	TM9	TM10	TM11	TM12	TM13	TM14	TM15	TM16	TM18	TM19	TM20	TM55	TM56	TM57	TM58
Full		.60										-.12				.33			.15					
2 vars		.58														.24			.14					
3 vars		.60										-.12				.33			.15					

Objective 7: Gaining a broader understanding and appreciation of intellectual/cultural activity (music, science, literature, etc.)

Model	Size	R^2	TM1	TM2	TM3	TM4	TM5	TM6	TM8	TM9	TM10	TM11	TM12	TM13	TM14	TM15	TM16	TM18	TM19	TM20	TM55	TM56	TM57	TM58
Full		.72												.18		.11					.15			
2 vars		.70												.26							.16			
3 vars		.72												.18		.11					.15			

Objective 8: Developing skill in expressing oneself orally or in writing

Model	Size	R^2	TM1	TM2	TM3	TM4	TM5	TM6	TM8	TM9	TM10	TM11	TM12	TM13	TM14	TM15	TM16	TM18	TM19	TM20	TM55	TM56	TM57	TM58
Full		.71	-.07							.06						.10			.14		.10			.11
2 vars		.66																	.23					.19
3 vars		.68																	.20		.11			.13
4 vars		.70								.07									.17		.10			.11
5 vars		.70								.06						.08			.14		.09			.09
6 vars		.71	-.07							.06						.10			.14		.10			.11

Objective 11: Learning to *analyze* and *critically evaluate* ideas, arguments, and points of view

Model	Size	R^2	TM1	TM2	TM3	TM4	TM5	TM6	TM8	TM9	TM10	TM11	TM12	TM13	TM14	TM15	TM16	TM18	TM19	TM20	TM55	TM56	TM57	TM58
Full		.78	-.05						.14					.09					.08		.07	.10		
2 vars		.76							.22													.20		
3 vars		.77							.18										.11		.15			
4 vars		.78							.16										.09		.09	.10		
5 vars		.78							.13					.07					.08		.07	.09		
6 vars		.78	-.05						.14					.09					.08		.07	.10		

Objective 49: Developing knowledge and understanding of diverse perspectives, global awareness, or other cultures

Model	Size	R^2	TM1	TM2	TM3	TM4	TM5	TM6	TM8	TM9	TM10	TM11	TM12	TM13	TM14	TM15	TM16	TM18	TM19	TM20	TM55	TM56	TM57	TM58
Full		.66																			.81			
1 var		.66																			.81			

Objective 50: Developing ethical reasoning and/or ethical decision making

Model	Size	R^2	TM1	TM2	TM3	TM4	TM5	TM6	TM8	TM9	TM10	TM11	TM12	TM13	TM14	TM15	TM16	TM18	TM19	TM20	TM55	TM56	TM57	TM58
Full		.63							.23			.21									.44			
1 var		.58																			.76			
2 vars		.61							.30												.53			
3 vars		.63							.23			.21									.44			

Objective 51: Learning to apply knowledge and skills to benefit others or serve the public good

Model	Size	R^2	TM1	TM2	TM3	TM4	TM5	TM6	TM8	TM9	TM10	TM11	TM12	TM13	TM14	TM15	TM16	TM18	TM19	TM20	TM55	TM56	TM57	TM58
Full		.83										.28									.23	.17	.30	
1 var		.73																				.86		
2 vars		.79										.38										.56		
3 vars		.82										.31									.32		.36	
4 vars		.83										.28									.23	.17	.30	

Objective 52: Learning appropriate methods for collecting, analyzing, and interpreting numerical information

Model	Size	R^2	TM1	TM2	TM3	TM4	TM5	TM6	TM8	TM9	TM10	TM11	TM12	TM13	TM14	TM15	TM16	TM18	TM19	TM20	TM55	TM56	TM57	TM58
Full		.53																		.73				
1 var		.53																		.73				

Objective 53: Learning how to find, evaluate, and use resources to explore a topic in depth

Model	Size	R^2	TM1	TM2	TM3	TM4	TM5	TM6	TM8	TM9	TM10	TM11	TM12	TM13	TM14	TM15	TM16	TM18	TM19	TM20	TM55	TM56	TM57	TM58
Full		.71	-.14							.31						.26							.20	.30
1 var		.60														.78								
2 vars		.67								.38														.51
3 vars		.70								.28						.32								.32
4 vars		.71								.29						.21							.18	.26
5 vars		.71	-.14							.31						.26							.20	.30

Objective 54: Gaining a basic understanding of the subject (e.g., factual knowledge, methods, principles, generalizations, theories)

Model	Size	R^2	TM1	TM2	TM3	TM4	TM5	TM6	TM8	TM9	TM10	TM11	TM12	TM13	TM14	TM15	TM16	TM18	TM19	TM20	TM55	TM56	TM57	TM58
Full		.78						.24	.19					.26			-.16					.26	.14	
1 var		.71												.84										
2 vars		.74							.35					.54										
3 vars		.76						.37	.26													.30		
4 vars		.77						.26	.22					.22								.24		
5 vars		.77						.24	.20					.29			-.13					.31		
6 vars		.78						.24	.19					.26			-.16					.26	.14	