AC 2008-737: AN INVESTIGATION OF THE RELATIONSHIP BETWEEN GRADUATE TEACHING ASSISTANT PERCEPTIONS AND SUCCESS OF ACTIVE LEARNING TECHNIQUES IN AN ENGINEERING EDUCATION COURSE

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An Investigation of the Relationship between Graduate Teaching Assistant Perceptions and Success of Active Learning Techniques in an Engineering Education Course

Abstract

Active learning is extremely prevalent in discussions of how to improve teaching and learning in both undergraduate and graduate engineering courses. However, active learning may not always lead to success. Rather, characteristics of the students enrolled and of the course material may influence whether or not active learning is met with resistance. This project examines the relationship between graduate students' perception of active learning techniques and the success of these techniques in an engineering education course entitled, "Teaching Seminar for Graduate Assistants." The context of the project surrounds three sections of a course which were taught in the same semester by the same instructor on different days of the week. Although the same activities were used in each section, resistance was more evident in one section as compared to the other two. Students across all sections were surveyed to examine their perceptions regarding course effectiveness, relevance of the course, helpfulness of class activities, and views on active learning. Students who found the course to be relevant to themselves and their future careers were more likely to provide a positive perspective on active learning techniques. In addition to a detailed analysis of the scale data, the limitations of the study regarding the specialized population enrolled in the course are discussed.

Introduction

Walk into any faculty development seminar in the College of Engineering on any campus and you are likely to hear a similar mantra. If an instructor wants to improve his or her teaching and subsequently increase student learning, he or she should use active learning techniques. Active learning is arguably the most prescribed solution to easing educational problems and enhancing student learning for faculty within any discipline. In fact, research has generally supported that active learning strategies are likely to result in higher student engagement and greater learning gains than traditional instructor-centered methods.[1] However, what is missing from the literature is a balanced perspective regarding the use of active learning including empirical research on why active learning techniques might fail and on specific techniques to use when active learning is seemingly ineffective.

The purpose of this paper is to begin to explore this side of active learning, focusing on what variables might be related to or influence students' perceptions of active learning techniques. In order to explore this perspective, an examination of three sections of an engineering education course is described. These three sections had seemingly differential impact, although the instructor and time of day remained consistent.

Research on how students learn has reiterated that students need to be actively engaged with course material. For example, the National Research Council states that, "Overall, the new

science of learning is beginning to provide knowledge to improve significantly people's abilities to become active learners who seek to understand complex subject matter and are better prepared to transfer what they have learned to new problems and settings" (p. 13).[2] While the instructor may hope that students enter a course already intrinsically motivated to be actively involved with the material, this is unlikely to happen in most courses. Thus, the thrust is put upon the instructor to develop activities which encourage or even require the students to engage in the material, with the ultimate goal of becoming active learners.

Developing effective active learning techniques that students positively respond to is a challenging task, as the NRC notes, "How does an instructor provide an active learning experience, provide feedback, accommodate different learning styles, make students' thinking visible, and provide scaffolding and tailored instruction to meet specific student needs…?" (p. 182). [2] The instructor has the difficult task of developing active learning experiences that are beneficial to students who possess different characteristics and preferences for learning.

Research in the literature has often focused on the effectiveness of very specific effective active learning elements. [3, 4, 5, 6] However, less of the focus has been on identifying more general features of active learning techniques which tend to be less successful in a classroom setting or on the characteristics of students which might influence the success of a particular element. In reality, students might be resistant to the use of active learning techniques in the classroom. In a recent 2007 paper, Felder[7] details some examples of the reactions of "grumpy" students who express reluctance in partaking in classroom activities, particularly those involving groups. Some of these reactions include feelings that group activities are a waste of time, a preference for working individually or with friends, and a dislike of specific types of activities such as writing and presentations.

Given these reactions of students, instructors might have some difficulty with implementing various active learning elements. Some students are not used to the unstructured nature of many types of active learning elements. Other students, who may have more reticent personalities, feel more comfortable with the traditional passive role utilized in a traditional lecture environment. As Felder[8] states in an earlier paper, "The students, whose teachers have been telling them everything they needed to know from the first grade on, don't necessarily appreciate having this support suddenly withdrawn. Some students view the [student centered] approach as a threat or as some kind of game, and a few may become sullen or hostile when they find they have no choice about playing."

In order to better understand how and why active learning elements might be effective, research is necessary to examine how group dynamics, student characteristics, and activity characteristics might contribute to the success of various teaching strategies. The investigation of student perceptions of active learning techniques and the relationship to various student characteristics is just beginning. As Machemar and Crawford[9] note, ""How the students perceive or value these techniques is in need of further study. There is limited and conflicting information about student preferences for active, cooperative, and traditional teaching techniques."

This paper just begins to touch the surface of this research area by focusing on students' perceptions of active learning and how this relates to perceptions of course effectiveness,

feelings of course relevance. This paper will explore three research questions in the context of an engineering education course focusing on teaching concepts for graduate students. These research questions and hypotheses follow:

1. What is the relationship between students' perceived helpfulness of the course activities and their perception of active learning?

We hypothesize that those students who have a positive perception of active learning techniques will also find the activities used in a specific course to be helpful. Given that the majority of the activities used in the course are designed to have students actively involved with their learning, it is likely that those students with a more positive perception of active learning techniques in general will also likely find the activities used in the course to be positive.

2. What is the relationship between students' perceived relevance of course and their perception of active learning?

We hypothesize that students who perceive the course to be more relevant to their future and of greater interest to them will be more likely to endorse principles of active learning. Many of the students in the class are planning careers in industry as opposed to academic positions. We hypothesize that students who have a greater interest in teaching will also likely feel more positive about teaching strategies that have an active component.

3. What differences exist between seemingly successful courses using active learning and those which do not seem to be as successful?

The scenario investigated for this report, described in more detail below, involves an instructor who taught three sections of the same course with varying degrees of success. Students in one section were less accepting of the active learning techniques and expressed more resistance. Specifically, we hypothesize that the students in the seemingly less successful section will a) find the course to be less effective, b) express less perceived relevance in the course, c) have less positive views on the helpfulness of class activities to learning, and d) have a less positive view of active learning.

Methods

Context of Study

The course under investigation is entitled, "Teaching Seminar for Graduate Assistants." This course is a requirement of all engineering students who will be teaching in the College of Engineering, including students who are leading lectures, labs, or recitations. In addition, some students whose primary assistantship responsibility consists of grading and holding office hours also enroll in the course. While the course is required only for students who are teaching, many students whose primarily role in the classroom is grading or one-on-one tutoring also choose to take the course for various reasons such as encouragement by their advisor or interest in the material.

Given the focus of the course is teaching, the instructional strategies used within the course varied from week to week, in order to provide a model for students. Each week, a selection of instructional methods was demonstrated so that students could get ideas for techniques to try in their own courses, if teaching. These different active learning elements included discussion, interactive lectures, demonstrations, debates, small-group activities, and student-lead activities.

The participants in this study were graduate students enrolled in the engineering education course. Students within three sections of the course were asked to participate. The same instructor led all three sections. Each section was offered during afternoon hours on different days of the week. Rather than having one section of over fifty students, multiple sections of the course with smaller class sizes were offered with the intention that the instructor can better know the students and that more interaction could be possible.

The instructor of the course acknowledged that the course activities seemed to be differentially accepted by the students in different sections. One section of the course particularly stood out as being problematic. For example during one class session, the instructor modeled how one can make a lecture more interactive and showed a video demonstration. The students in two of the sections demonstrated extreme interest in the example, to the point where the instructor had difficulty bringing the course back to order. In the third section, the same example elicited merely a few head nods from the students, without the same display of enthusiasm. Additionally, the instructor could sense that the students in the third section did not enjoy some of the active learning activities, whereas they were accepted positively in the other two sections. Students expressed some resistance to different group activities throughout the semester.

Participants

Of the 48 students enrolled across all three sections, a total of 44 students participated in the study. The number of students included 9 in Section 1, 17 in Section 2, and 18 in Section 3. The students were from a variety of departments in the College of Engineering including electrical engineering (17), computer science and engineering (10), industrial engineering (9), engineering science and mechanics (8), aerospace engineering (1), architectural engineering (1), chemical engineering (1), and mechanical engineering (1). A total of 14 students (29.2%) of the students were female. A total of 47.9% of the students were international coming from countries such as India, China, Iran, and Japan. Table 1 shows the student composition by the different course sections.

Table 1: Student Composition by Section

Section	Female Students	International Students	Most frequent major
Section 1	6 (54.5%)	3 (27.3%)	Industrial engineering 5 (45.5%)
Section 2	3 (15.8%)	11 (57.9%)	Electrical engineering 5 (26.3%)
Section 3	5 (27.8%)	9 (50%)	Electrical engineering 9 (50%)

Of the 44 students who participated in the study, only 15 or 34.1% were considering an academic position for their future career. The remaining 65.9% of the students were considering careers in government or industry. A total of 28 or 63.6% students were concurrently teaching a course, lab, or recitation.

Instrument

Students completed a survey on the last day of the course which was composed of several subscales, described below. Items from all subscales are located in the appendix. All items were developed for the purpose of this study.

a) The Course Effectiveness (CE) subscale consisted of 5 Likert-type items concerning the link between the course and the intended course objectives. Questions included items asking about students' interest in teaching, their comfort with planning a course, and their level of understanding of various instructional and assessment methods. Students rated each item from Strongly Disagree to Strongly Agree which was numerically coded from 1 to 5 and summed. Reliability estimates using Cronbach's alpha were moderately high at 0.759.

b) The Perceived Relevance (PR) subscale consisted of 2 items which asked students about their interest in the course and the connection between the course and their future career. This subscale used the same anchors as the CE subscale and again was coded and summed. Although the subscale consisted of only 2 items, reliability estimates were moderately high with Cronbach's alpha equal to 0.695. Relevance was also measured by examining students' report of their anticipated career path.

c) The Helpfulness of Class Activities (HCA) scale consisted of 7 items which asked the students to rate the helpfulness of various course activities in contributing to their understanding of the course material. These items were rated using a 4-point scale ranging from "Not at all helpful" to "Very helpful." The items were also coded and summed in order to obtain a general estimate of the perceived helpfulness of the class activities. Reliability estimates were also moderately high at 0.742.

d) The Perceptions of Active Learning (PAL) subscale consisted of 8 Likert-type items which asked the students their comfort level with active learning techniques, their proclivity regarding working alone or with others, and their preference for traditional instructions. The items are rated on a scale from Strongly Disagree to Strongly Agree, which is coded to a numeric scale so that sum scores could be utilized in analysis with all negatively worded items (1, 2, 4, 6, 7, and 8) reverse coded. The scale was found to have moderate reliability with an alpha of 0.682.

Results

Table 2 displays the descriptive statistics for the students' scores on each subscale. Table 3 displays the correlation matrix for each of the subscale scores.

Table 2: Descriptive Statistics for Survey Subscales Scores

Subscale	N	Min	Max	Mean	Standard deviation
Course Effectiveness (CE)	44	10	25	19.23	2.83
Perceived Relevance (PR)	44	4	10	7.00	1.60
Helpfulness of Class Activities (HCA)	38	13	29	20.71	3.56
Perceptions of Active Learning (PAL)	44	16	35	24.80	4.41

Table 3: Correlation Matrix for Survey Subscale Scores

		CE	PR	HCA	PAL
CE	Pearson Correlation	1			
PR	Pearson Correlation	.555(**)	1		
HCA	Pearson Correlation	.374(*)[1]	.260	1	
PAL	Pearson Correlation	.214	.537(**)	.192	1

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

[1] n=44 for all correlations except for HCA for which n=38

1. What is the relationship between students' perceived helpfulness of the course activities and their perception of active learning?

In order to explore this hypothesis, the correlation between the HCA and PAL subscales was examined. This correlation was not found to be significantly different from zero with a value of 0.192 (p=0.248). Across all three sections, certain activities were found to have lower average ratings, as displayed in Table 4. The item with the lowest mean involved the teaching philosophy, which was the least active activity included in the course.

Table 4: Item means for HCA Scale

	Mean	Standard Deviation
Interactive lecture	3.12	.86
Writing course objectives	3.00	.72
Large group discussions	2.95	.85
Small group activities	2.86	.99
Classroom debate	2.81	.86
Opportunities to "teach"	2.80	.75
Writing the teaching philosophy	2.67	.87

2. *What is the relationship between students' perceived relevance of course and their perception of active learning?*

The correlation between the PR and the PAL subscales was moderately large with a value of 0.537, found to be significantly different from zero with p=0.000. Students who found the course to be relevant to their career also had more positive perceptions of active learning.

This finding was collaborated by examining differences in PAL scores between students who were considering an academic career (mean = 26.80, standard deviation = 4.75) versus those considering a nonacademic career (mean = 23.76, standard deviation = 3.92). The average difference in scores was significantly different with t= 3.31 and p=0.002.

These results support the conclusion that graduate students who have an interest in teaching as a career are more likely to have a positive perception of active learning than graduate students who have less interest in teaching.

3. What differences exist between seemingly successful classes using active learning and those which do not seem to be as successful?

The instructor acknowledged that the active learning activities seemed to be more effective in Sections 1 and 2 as compared to Section 3. Tables 5 and 6 display the descriptive statistics of the subscales by section.

Table 5: Descriptive Statistics for CE and PR subscales by Section

	Sample size	**CE**		**PR**	
		Average	Standard Deviation	Average	Standard Deviation
Section 1	11	20.78	1.79	7.67	1.80
Section 2	19	19.18	3.00	6.76	1.79
Section 3	18	18.50	2.90	6.89	1.28

Table 5: Descriptive Statistics for HCA and PAL subscales by Section

	HCA		**PAL**	
	Average	Standard Deviation	Average	Standard Deviation
Section 1	21.38	3.25	27.56	5.92
Section 2	21.00	4.13	24.71	4.12
Section 3	20.00	3.01	23.50	3.31

In order to examine the student characteristics of the seemingly less effective course, one-way ANOVAs were utilized on each of the four subscales.

No statistically significant differences among the three sections were found for any of the subscales. First, no significant differences were found on the CE score ($F=2.047$, $p=0.142$, $df=2, 41$) although the mean scores did decrease in the hypothesized direction. While there may be a minor difference in the perceived effectiveness of the course by section, this difference is not large enough to be statistically significant perhaps due to the small sample sizes in each section.

Second, no statistical difference was found on the PR score by section ($F=1.010$, $p=0.373$, $df=2,41$). The mean differences on the PF scale also were quite minimal. This suggests that students across all three sections had a similar perception regarding the relevance of the course to their future career.

No statistical differences were found among the three sections on the HCA scale ($F=0.467$, $p=0.631$, $df=2,35$). This suggests that students rated the helpfulness of the various course activities in a similar manner.

Lastly, no statistical difference was found on the PAL scale. While these mean differences were not statistically significant, ($F=2.75$, $p=0.076$, $df=2,41$), the average scores were in the direction as hypothesized. Once again, although there is not a significantly significant difference potentially due to the small sample size and low power, there may be an effect which is not detected.

Conclusions and Discussion

Given the emphasis of active learning in engineering education, more research is needed to better understand students' perceptions of the techniques. This study just begins to help in the

understanding of reasons why active learning techniques might be successful or unsuccessful in a course.

Perhaps the most interesting finding of this study is the relationship between students' perceived relevance of the course and their perception of active learning techniques. Given the subject matter of the course, perhaps this is not surprising. Students who are interested in teaching or who are considering teaching as a career are perhaps more convinced on the effectiveness of active learning. Students who have less interest in the course material and perceive it to be less important for their future career path may not have been convinced as strongly about the effectiveness of active learning elements. The relationship between course relevance and perception of active learning may not be as strong for courses in other disciplines. One alternative interpretation of this finding may be that students who have an interest in an academic career may be interested in all topics of the course related to teaching and learning. The more positive perception of active learning techniques may just be one example of their greater interest in the more general topic covered in the course.

Surprisingly, there were no statistically significant findings among the three sections with seemingly differential effectiveness relating to acceptance of active learning techniques. The lack of statistical significance is likely due to the small sample sizes for each class section, as the observed means are in the hypothesized direction for the subscales measuring perception of active learning and course effectiveness. Additional studies should examine this question again using courses with larger enrollment.

One limitation of this research is the specialized population of students in the course. The course consisted of graduate teaching assistants from around the College of Engineering. Some of these students were independently teaching a course, lab, or recitation. Some students were not independently teaching that semester. There could potentially be two separate populations of students in the course and the results could likely be influenced by their teaching role in the given semester. Whether or not these findings can be generalized to other graduate courses or to the population of undergraduate students is questionable.

Another possible limitation of the study is the instructors' perception of the course effectiveness, which could be potentially biased. It is possible that the instructor had a decrease in enthusiasm or energy by the last time the course was being taught. This could potentially impact the responsiveness of the students and also the instructor's perception of the responsiveness of the class.

One future area for research is on the usefulness of the PAL subscale or other similar instruments at the start of a course. Would knowing that students are less receptive to active learning elements be helpful to an instructor at the start of a course? This instrument should be further developed to help an instructor to know what to expect when planning for a course filled with active learning elements. Unfortunately, a pre-test was not administered in this study, which would have provided an interesting examination of change in perceptions after completion of the course. Additional research is necessary to discover techniques that an instructor can use when faced with resistance to active learning.

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APPENDIX

Course Effectiveness (CE) Subscale

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. As a result of this course, I am more interested in teaching.	☐	☐	☐	☐	☐
2. As a result of this course, I feel more comfortable planning my own course.	☐	☐	☐	☐	☐
3. As a result of this course, I better understand the advantages and disadvantages of various instructional methods.	☐	☐	☐	☐	☐
4. As a result of this course, I better understand the advantages and disadvantages of various assessment methods.	☐	☐	☐	☐	☐
5. As a result of this course, I will feel more confident the next time I teach a course.	☐	☐	☐	☐	☐

Perceived Relevance (PR) Subscale

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
6. I can see a connection between this course and my future career.	☐	☐	☐	☐	☐
7. I am interested in concepts related to teaching and learning.	☐	☐	☐	☐	☐

Helpfulness of Class Activities (HCA) Subscale

Please rate each of the activities in terms of how helpful each was to your understanding of teaching practices:

	Not at all helpful	Somewhat helpful	Helpful	Very helpful
1. Writing course objectives	☐	☐	☐	☐
2. Classroom debate on assessment techniques	☐	☐	☐	☐
3. Interactive lecture showing demonstration (i.e. the balls on the ramp)	☐	☐	☐	☐
4. Small group activities in the classroom	☐	☐	☐	☐
5. Large group discussions	☐	☐	☐	☐
6. Opportunities to "teach" the class	☐	☐	☐	☐
7. Writing the teaching philosophy	☐	☐	☐	☐

Perceptions of Active Learning Subscale (PAL)

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. I am more comfortable in courses which primarily use lecture techniques.	☐	☐	☐	☐	☐
2. I would rather work alone than in a group.	☐	☐	☐	☐	☐
3. I feel comfortable in large-group discussions.	☐	☐	☐	☐	☐
4. I am reluctant to speak during classroom discussions.	☐	☐	☐	☐	☐
5. I feel that I have a lot to learn from the experiences of other students in my courses.	☐	☐	☐	☐	☐
6. I like to think about concepts for a while before I discuss them with others.	☐	☐	☐	☐	☐
7. Working in small groups during class wastes valuable time.	☐	☐	☐	☐	☐
8. As a student, I prefer traditional methods of instruction.	☐	☐	☐	☐	☐