Implementation and Faculty Reflection of an Instrument to Measure Student Response to Instructional Practices

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Abstract

Research has provided evidence on the benefits of active learning on student learning and success in the engineering classroom yet the adoption has been slow. Engineering classrooms in the USA remain traditionally lecture and instructor based. As numerous engineering education grants receive funding (Borrego & Olds, 2011), and the amount of researchers increase, one has to wonder why many engineering classrooms remain lecture based when it has been shown that nontraditional teaching methods are more effective at promoting student learning (Freeman et al., 2014; Johnson, Johnson, & Smith, 1991; M. Prince, 2004). Nontraditional teaching methods are defined in the paper as teaching methods that incorporate student engagement in the classroom and can be compared to the lack of student engagement shown by traditional lecture. Nontraditional teaching methods in engineering education have been documented in many different forms such as pedagogies of engagement (Smith, Sheppard, Johnson, & Johnson, 2005), inductive teaching methods (M. J. Prince & Felder, 2006), and research based instructional strategies (Borrego, Cutler, Prince, Henderson, & Froyd, 2013). Prior research has suggested that students' response may have a significant effect on instructors' willingness to adopt different types of instruction. The research team created an instrument to measure the effects of several variables on student response to instructional practices. The survey queried types of instruction which were separated into four factors (interactive, constructive, active, and passive); strategies for using in-class activities broken into two factors (explanation and facilitation); and student responses to instruction divided into five factors (value, positivity, participation, distraction, and evaluation). The team initially decided that of the engineering faculty that do use nontraditional teaching methods, the following research questions were important:

1. What are the characteristics of engineering faculty that use nontraditional teaching methods?
2. How do engineering faculty report on their use of nontraditional teaching methods and what are their experiences with nontraditional teaching methods?

By answering these research questions, we hope to paint a valid picture of how engineering faculty members go on about using nontraditional teaching methods in their classrooms. There has been numerous literature about the different types of teaching methods and their effectiveness, and we aim to showcase engineering faculty that actually use these research based teaching methods in their classrooms with regards to their departmental constraints and

backgrounds. This paper will describe the use of an instrument created during the project to measure Student Response to Instructional Practices, a useful tool for understanding the relationship between the type of instruction used and students' response and faculty use of the tool. This paper will share a sample of the summary document provided to the faculty after the course and will discuss a faculty member's reflections of the survey results.

Introduction

What will STEM education look like in 2025? How can faculty members be motivated to adapt their methods when the educational benefits of active learning are already well established? In a meta-analysis of 225 studies in STEM (science, technology, engineering, and mathematics) disciplines, Freeman et al. (2014) found that "active learning leads to increases in examination performance that would raise average grades by a half a letter, and that failure rates under traditional lecturing increase by 55% over the rates observed under active learning." Other studies show that active learning can be especially effective for educating a diverse student body (Prince, 2004; Seymour & Hewitt, 1997) and for increasing the retention rate of students in STEM programs (Angelo & Cross, 1993; Blackburn & Lawrence, 1995; Prince, 2004; Prince & Felder, 2006). In short, the goal to increase the number and diversity of students receiving STEM degrees could be achieved in some measure by simply abandoning traditional lecturing in favor of active learning. As a result of these and similar findings, the first recommendation of the President's Council of Advisors on Science and Technology report "Engage to Excel" is to "catalyze widespread adoption of empirically validated teaching practices" such as active learning (PCAST, 2012). Yet the numbers of classrooms transformed by these engaging teaching practices remains below optimal. This paper will be sharing results of reflective faculty interviews after a semester in which they implemented some version of active learning and volunteered to have their students participate in three stages of a StRIP study.

The impetus faculty members have to create a more engaging classroom are obvious yet student resistance has been recognized as a significant factor contributing to the slow adoption of active learning in the engineering classroom (Finelli, Richardson, & Daly, 2013; Prince, Borrego, Henderson, Cutler, & Froyd, 2014). Student resistance is defined as negative responses towards participation in active learning exercises. Past efforts to understand this student response have included a 19- item topology to describe student resistance developed by Kearney, Plax, and Burroughs (1991). Guided by this work, Weimer (2013) presented a simpler classification of student resistance using three basic types: *Passive, non-verbal*, in which students might offer excuses for not doing assignments, pretend to comply or simply not participate; *Partial compliance*, whereby students might complete a task poorly or with minimal effort; and *Open resistance* in which students might openly voice concerns or objections. Our work used Expectancy Violation Theory (Gaffney, Gaffney, & Beichner, 2010; Koermer & Petelle, 1991) as an explanation for student resistance. According to this theory, resistance can occur when students' *expectations* about classroom teaching practices are *violated* by what actually occurs.

For example, if students expect to take notes while the instructor lectures, but if the instructor asks students to work in small groups instead, students may demonstrate resistance. Active learning requires additional participation from students which often conflicts with their expectations.

Our larger research study has worked to develop instruments to assess students' and instructors' expectations about classroom teaching practices and to characterize student resistance to instructor's use of active learning in the classroom (Shekhar et.al., 2015, DeMonbrun, et.al. 2017, Nguyen, et.al., 2016). These instruments are allowing us to study the way student and instructors' expectations align over time, investigate the subsequent impact on student resistance to active learning, and identify strategies that instructors might use to reduce student resistance by aligning student and instructor's expectations

Methods

Survey Instrument and Implementation

The StRIP Survey contains multiple sections and took an average of fifteen minutes to complete. The first section focused on students' responses to instructional practices or in-class activities (Figure 1), the second section focused on how the students perceived the administration of in-class activities by the instructor (Figure 2), the third section directly asked students to measure overall satisfaction with the course and the instructor (Figure 3), the fourth and fifth sections asked students what final grade they expected in the course and the number of courses they have already taken with in-class activities (Figure 4), and the sixth section asked students to report the frequency of in-class activities and indicate which in-class activities would comprise their ideal course (Figure 5).

1. In this course, when the instructor asked you to do an in-class activity (e.g., solve problems in a group during class or discuss concepts with classmates), **how often did you react in the following ways?**	1. Almost never (< 10% of the time)	2. Seldom (~30% of the time)	3. Sometimes (~ 50 % of the time)	4. Often (~ 70 % of the time)	5. Very Often (> 90 % of the time)
a. I disliked the activity and voiced my objections.	1	2	3	4	5
b. I focused on doing specifically what the instructor asked, rather than on mastering the concepts.	1	2	3	4	5
c. I rushed through the activity, giving minimal effort.	1	2	3	4	5
d. I felt positively towards the instructor/class.	1	2	3	4	5
e. I tried my hardest to do a good job.	1	2	3	4	5
f. I distracted my peers during the activity.	1	2	3	4	5
g. I pretended but did not actually participate.	1	2	3	4	5
h. I felt the effort it took to do the activity was worthwhile.	1	2	3	4	5
i. I participated actively (or attempted to).	1	2	3	4	5
j. I talked with classmates about other topics besides the activity.	1	2	3	4	5
k. I felt the instructor had my best interests in mind.	1	2	3	4	5
l. I saw the value in the activity.	1	2	3	4	5
m.I felt the time used for the activity was beneficial.	1	2	3	4	5
n. I enjoyed the activity.	1	2	3	4	5
o. I surfed the internet, checked social media, or did something else instead of doing the activity.	1	2	3	4	5

Figure 1: Responses to Instructional Practices Section

2. In this course, when the instructor asked you to do an in-class activity (e.g., solve problems in a group during class or discuss concepts with classmates), **how often did the instructor do the following things**?	1. Almost never (< 10% of the time)	2. Seldom (~30% of the time)	3. Sometimes (~ 50 % of the time)	4. Often (~ 70 % of the time)	5. Very Often (> 90 % of the time)
a. Clearly explained what I was expected to do for the activity.	1	2	3	4	5
b. Clearly explained the purpose of the activity.	1	2	3	4	5
c. Discussed how this activity related to my learning.	1	2	3	4	5
d. Solicited my feedback or that of other students about the activity.	1	2	3	4	5
e. Used activities that were the right difficulty level (not too easy, not too difficult).	1	2	3	4	5
f. Walked around the room to assist me or my group with the activity, if needed.	1	2	3	4	5
g. Encouraged students to engage with the activity through his/her demeanor.	1	2	3	4	5
h. Gave me an appropriate amount of time to engage with the activity.	1	2	3	4	5

Figure 2: Administration of In-Class Activities by the Instructor Section

3. Please rate your level of agreement with the following items.	1. Strongly disagree	2. Disagree	3. Neutral	4. Agree	5. Strongly Agree
a. Overall, this was an excellent course.	1	2	3	4	5
b. Overall, the instructor was an excellent teacher.	1	2	3	4	5

Figure 3: Overall Course and Instructor Evaluation Section

4. What final grade do you expect to receive in this course?

F D- D D+ C- C C+ B- B B+ A- A A+

5. In how many of your college courses has the instructor asked you to do an in-class activity at least once a week?

☐ Every one of my college courses ☐ Almost all of my college courses
☐ About half of my college courses ☐ A few of my college courses
☐ None of my college courses

Figure 4: Final Grade Expectations and Prior In-Class Activities Section

Summary Results

Students reported their expectations of classroom instruction activities at the beginning (pre) and two weeks into the semester. Students also report the perceived occurrence of classroom instruction activities at the end of the semester (post). The average of students' expectations of classroom instruction at the three different times are listed below in Figure 6. The error bars represent the standard deviation from the mean score.

6. For each of the following things, please indicate how often you did each thing **in this course** and how often you would like to do each **in your ideal course**.

	In this course, how often did you						**In your ideal course**, how often would you like to					
	1. Never	2. Seldom (1-5 times/semester)	3. Sometimes (5-10 times/semester)	4. Often (once a week)	5. Very often (more than once/week)		1. Much less	2. Slightly less	3. About the same	4. Slightly more	5. Much more	
a. Listen to the instructor lecture during class.	1	2	3	4	5		1	2	3	4	5	
b. Brainstorm different possible solutions to a given problem.	1	2	3	4	5		1	2	3	4	5	
c. Find additional information not provided by the instructor to complete assignments.	1	2	3	4	5		1	2	3	4	5	
d. Work in assigned groups to complete homework or other projects.	1	2	3	4	5		1	2	3	4	5	
e. Make individual presentations to the class.	1	2	3	4	5		1	2	3	4	5	
f. Be graded on my class participation.	1	2	3	4	5		1	2	3	4	5	
g. Study course content with classmates outside of class.	1	2	3	4	5		1	2	3	4	5	
h. Assume responsibility for learning material on my own.	1	2	3	4	5		1	2	3	4	5	
i. Discuss concepts with classmates during class.	1	2	3	4	5		1	2	3	4	5	
j. Make and justify assumptions when not enough information is provided.	1	2	3	4	5		1	2	3	4	5	
k. Get most of the information needed to solve the homework directly from the instructor.	1	2	3	4	5		1	2	3	4	5	
l. Be graded based on the performance of my group.	1	2	3	4	5		1	2	3	4	5	
m. Preview concepts before class by reading, watching videos, etc.	1	2	3	4	5		1	2	3	4	5	
n. Solve problems in a group during class.	1	2	3	4	5		1	2	3	4	5	
o. Solve problems individually during class.	1	2	3	4	5		1	2	3	4	5	
p. Answer questions posed by the instructor during class.	1	2	3	4	5		1	2	3	4	5	
q. Ask the instructor questions during class.	1	2	3	4	5		1	2	3	4	5	
r. Take initiative for identifying what I need to know.	1	2	3	4	5		1	2	3	4	5	
s. Watch the instructor demonstrate how to solve problems.	1	2	3	4	5		1	2	3	4	5	
t. Solve problems that have more than one correct answer.	1	2	3	4	5		1	2	3	4	5	
u. Do hands-on group activities during class.	1	2	3	4	5		1	2	3	4	5	

Figure 5: Actual and Ideal Instructional Practices Section

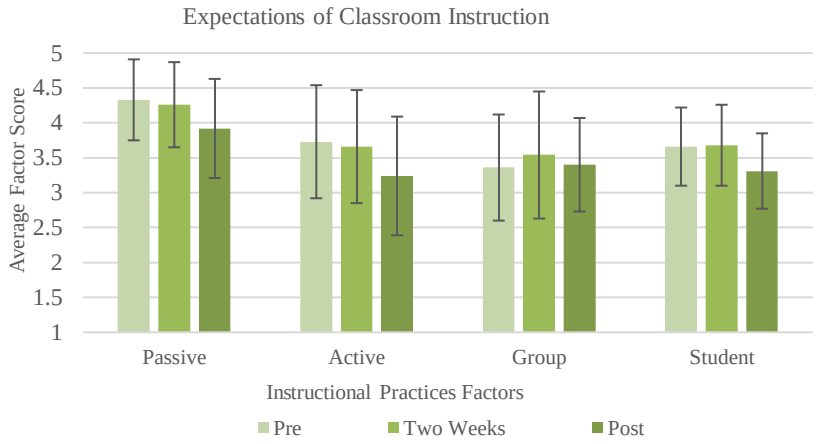

Figure 6. Average student's expectations of classroom instruction

For passive traditional lecture (passive), active learning lecture (active), and student led activities (student) instructional factors, students began with higher average expectations of these classroom instruction activities and ended up with less of what was actually performed in the classroom. The group work (group) instructional factor started with lower expectations, had higher expectations two weeks into the course, and ended with less at the end of the course. Overall, these instructional factors showed that their expectations of instructional activities were often higher than what actually occurred in the course, and students' expectations were violated, but only in the way that students expected more than what they actually received.
Students' responses to the active learning classroom were surveyed in the final post survey. The average of students' responses or types of responses are provided in Figure 7.

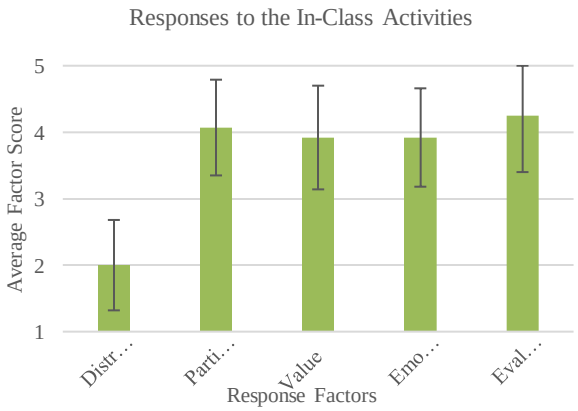

Figure 7. Average students' responses to the in-class activities

Overall, we see that students responded very positively to the in-class activities. Distraction, which accounts for negative responses, was the only type of response that scored below an average of three. We can see that students on average evaluated the course highly, and the students often participated, valued, and felt emotionally positive engaged with the in-class activities. These and more results were tabulated and used to generate Tables 1-6 which were

shared with the faculty. During a semi structured interview with a member of the research team, the faculty was able to reflect on the results about their particular course and this served as an avenue for development and improvement.

End of Course Faculty Report (EOCFR)

Instructor: Dr. QQQ
Course: Fundamentals of
Institution: East Coast U.
Semester: Spring 2015
Respondents: 25

1) **Classroom Activities**

Table 1: Reported Classroom activities

	Activity	**Instructor (Beginning of semester)**	**Student Response (End of semester)**
Most Frequent	Solve problems that have more than one correct answer	Very Often (More than once a week)	Seldom (1-5 times a semester)
	Discuss concepts with classmates during class	Often (One a week)	Sometimes (5-10 times a semester)
	Solve problems in a group during class	Often (One a week)	Sometimes (5-10 times a semester)
Least Frequent	Be graded based on my class participation	Never	Sometimes (5-10 times a semester)
	Make individual presentations to the class	Seldom (1-5 times a semester)	Never
	Be graded based on the performance of my group	Seldom (1-5 times a semester)	Seldom (1-5 times a semester)

2) **Student Response to Active Learning**

Table 2(a): Student Participation response during the active learning

	Reaction during Active Learning	**Student Response (End of semester)**
Most Frequent	I tried my hardest to do a good job	Often (~ 70 % of the time)
	I participated actively (or attempted to)	Often (~ 70 % of the time)
	I focused on doing specifically what the instructor asked, rather than on mastering the concepts.	Sometimes (~ 50% of the time)
Least Frequent	I distracted my peers during the activity	Almost never (< 10 % of the time)
	I distracted my peers during the activity	Almost never (< 10 % of the time)
	I surfed the internet, checked social media, or did something else instead of doing the activity	Almost never (< 10 % of the time)

Table 2(b): Student emotional and value response to active learning

Emotional and Value Response	**Student Response (End of semester)**
I felt positively towards the instructor/class	Sometimes (~ 50% of the time)

I felt the effort it took to do the activity was worthwhile	Often (~ 70 % of the time)
I felt the instructor had my best interests in mind	Often (~ 70 % of the time)
I saw the value in the activity	Often (~ 70 % of the time)
I felt the time used for the activity was beneficial	Sometimes (~ 50% of the time)
I enjoyed the activity	Sometimes (~ 50% of the time)

Table 2(c): Student overall response to Course and Instructor

Overall Rating	**Student Response (End of semester)**
Overall, this was an excellent course	Neutral
Overall, the instructor was an excellent teacher.	Agree

3) Table 3: Instructor Strategies

Instructor Response: *"Flipped class, work in groups, talk to your neighbors, watch YouTube videos" "*

Strategies	**Student Response (End of semester)**
Discussed how this activity related to my learning.	Often (~ 70 % of the time)
Gave me an appropriate amount of time to engage with the activity.	Often (~ 70 % of the time)
Clearly explained what I was expected to do for the activity	Sometimes (~ 50% of the time)
Clearly explained the purpose of the activity	Sometimes (~ 50% of the time)
Solicited my feedback or that of other students about the activity.	Sometimes (~ 50% of the time)
Used activities that were the right difficulty level (not too easy, not too difficult).	Sometimes (~ 50% of the time)
Walked around the room to assist me or my group with the activity, if needed.	Sometimes (~ 50% of the time)
Encouraged students to engage with the activity through his/her demeanor.	Sometimes (~ 50% of the time)

4) Student and Instructor Initial Expectations at the beginning of semester

Table 4(a): Student and Instructor Initial Expectations Gap at the beginning of semester

Class Expectation	**Instructor Response (Beginning of semester)**	**Student Response (Beginning of semester)**
Be graded on my class participation	Never	Sometimes (5-10 times a semester)
Solve problems that have more than one correct answer	Very Often (More than once/week)	Sometimes (5-10 times a semester)
Brainstorm different possible solutions to a	Sometimes (5-10 times a semester)	Sometimes (5-10 times a semester)
Ask the instructor questions during class.	Sometimes (5-10 times a semester)	Often (One a week)
Get most of the information needed to solve the homework directly from the instructor.	Never	Sometimes (5-10 times a semester)

Table 4(b): Instructor Response about student expectations (Beginning of Semester)

	Instructor Response (Beginning of Semester)
Overall, my expectations (for the items in Part 1 requiring student activity) compared to student expectations are	Almost the same
My expectations for students doing an in-class activity compared to student expectations are	Slightly Higher

5) Student Change in expectations

Table 5: Student expectations Gap (Beginning and two weeks of semester) and End of Semester response

Activity	Student Response (Beginning of the semester)	Student Response (After two weeks)	Student Response (End of Semester)
Find additional information not provided by the instructor to complete assignments	Often (One a week)	Sometimes (5-10 times a semester)	Sometimes (5-10 times a semester)
Work in assigned groups to complete homework or other projects.	Sometimes (5-10 times a semester)	Seldom (1-5 times a semester)	Sometimes (5-10 times a semester)
Make and justify assumptions when not enough information is provided	Sometimes (5-10 times a semester)	Seldom (1-5 times a semester)	Often (One a week)
Study course content with classmates	Sometimes (5-10 times a semester)	Sometimes (5-10 times a semester)	Sometimes (5-10 times a semester)
Solve problems individually during class.	Often (One a week)	Sometimes (5-10 times a semester)	Often (One a week)

6) Student expectations for Ideal Course

Table 6: Student expectations for Ideal Course (End of Semester)

	Classroom Activities
More of	Study course content with classmates outside of class.
	Discuss concepts with classmates during class.
	Answer questions posed by the instructor during class.
Less of	Find additional information not provided by the instructor to complete assignments.
	Solve problems that have more than one correct answer.
	Make individual presentations to the class.

Data from the project reveal some interesting patterns about how students react to class activities in these different learning environments. Students responded positively to in-class activities in all courses. This is an important finding for faculty concerned that students will view active learning as a departure from the instructor's teaching responsibility. Some instructors are concerned that students feel that they are paying (tuition) for the instructor's expertise, not to learn from other students or to engage in learning activities they could do just as easily outside of class. None of these concerns have been supported by the data.

The EOCFR Tables 1-6 show a comparison of initial faculty expectation and plans and student recommendations. Part 1 pertains to classroom activities. The instructor listed the activities he/she intended to use and that was compared with what the students perceived throughout the semester. One sees in Table 1 that these did not completely match. We shared with the faculty the most frequent and least frequent response by the students. Table 2 reflected the student responses to these various activities. Table 2a shows how the students reported on their "Reaction during Active Learning" while Table 2b is the "Student emotional and value response to active learning". Table 2c displays the final "Student overall response to Course and Instructor". Faculty are generally concerned that active learning may affect final course value

response so this was chosen to be a part of our survey. Table 3 pertains to "Instructor Strategies". These are strategies the faculty member uses and that we know from literature and prior experience that are integral in reducing student's resistance. This captures the student's memory of events and does not always match what the faculty member believes to have occurred. Table 4 is interesting because it gets to the heart of expectations. Table 4a shows a comparison in "Student and Instructor Initial Expectations at the beginning of semester". Table 4b "Instructor Response about student expectations (Beginning of Semester)" is from the instructor survey and causes the instructor to reflect on what he/she expects of the students. Table 5 displays the "Student expectations Gap (Beginning and two weeks of semester) and End of Semester response". This is valuable information because it shows how, based on the progress of the course, more or less of certain activities may actually occur. Table 6 is taken from the final survey and reflects student's opinions as to their ideal course and results have shown that Student expectations for Ideal Course (End of Semester).

Generally, the StRIP Survey provided valuable information that can all be related back to student responses and administered instructional practices. Information such as expected grades, ideal instructional practices, prior amount of classes taken with in-class activities, and how in-class activities were administered by the instructor can be correlated back to how students responded to instructional practices.

Conclusion of Study and Future Work

A conclusion from this study is that we found no evidence to support the common concern that instructor or course evaluations are negatively affected by adopting active learning strategies. This finding should serve as a reassurance to instructors who are hesitant to adopt active learning for fear of student resistance. Our findings suggest that students more often than not saw educational value in them, felt positively about them, and participated fully in the active learning activities. We also found evidence that the way instructors explain and facilitate active learning instruction influences student reactions. These findings corroborate the advice in the literature that has been previously based on more anecdotal evidence. In particular, when using active learning, instructors should choose activities of appropriate difficulty, clearly explain what students are expected to do during the activity, and clarify the benefit of the activity for students. It is also important for instructors to be sure to provide appropriate time and encourage student engagement through their demeanor and interactions with the class.

We identified four ways to characterize student resistance outcomes: how much students value the activities, students' positive attitude toward the activities, final course evaluations, and whether students participate in the activities. Confrontational, verbal resistance to active learning, particularly during class time, happens very rarely and less often than instructors

anticipate. During the interviews we shared with the faculty a couple of recommendations based on the greater study.

1. Instructors can do a lot to reduce student resistance and encourage students to participate in class. In fact, instructor strategies are a stronger predictor of many resistance outcomes than the type of activity, students' expected grades, or students' prior experiences with active learning.

2. Strategies that instructors use to reduce resistance group into two main categories: clear explanation of the activity and active facilitation of the activity. Both positively impact students' attitudes and willingness to participate, with explanation having a slightly stronger influence.

Understanding and reducing student resistance and other negative responses to in-class active learning was the rationale for our project. Our research also suggests that students responded positively to in-class activities, whether they were implemented in an active or traditional course. This is an important finding to add to the literature about student resistance, since this indicates that students are not as resistant as previously believed. In addition, these are important findings for faculty concerned that students will view active learning as shirking teaching responsibility. Faculty also benefit from a summary of the finding after the class and the process of reflection proves to be a valuable step for faculty development which tend to increase their motivation to persist in their chosen pedagogy.

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