Reducing Student Resistance to Active Learning: Strategies for Instructors

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In spite of considerable evidence of the effectiveness of active learning and other contemporary teaching methods, barriers to adoption of those methods, such as possible student resistance, continue to exist. This study addresses student resistance by analyzing data from 1,051 students who completed our Student Response to Instructional Practices (StRIP) instrument in 18 introductory engineering courses where active learning was implemented. Through descriptive statistics, correlation analyses, and hierarchical linear regression modeling, we demonstrate that students' perceptions of their instructors' use of explanation and facilitation strategies can have a significant impact on student resistance. This study provides a more complete picture of the relative efficacy of these strategies to reduce resistance and confirms that students' perceptions of their instructors' use of these strategies can influence both how students engage with active learning and how students evaluate the course and instructor. We provide evidence-based advice for both new and experienced instructors to reduce student resistance to active learning and other contemporary teaching methods.

Tremendous effort has been invested to improve STEM (science, technology, engineering, and mathematics) education by developing and documenting the effectiveness of contemporary teaching methods such as active learning (Freeman et al., 2014; Prince, 2004), peer instruction (Mazur, 1997), cooperative learning (Johnson, Johnson, & Smith, 1991), and problem-based learning (Strobel & van Barneveld, 2009). Research has successfully shown that these teaching practices can improve student learning, engagement, and interest in STEM (e.g., Freeman et al., 2014; Seymour & Hewitt, 1997; Smith, Sheppard, Johnson, & Johnson, 2005). Despite ample evidence, though, the translation of educational research to actual classroom practice has been slow (American Society for Engineering Education [ASEE], 2012; Friedrich, Sellers, & Burstyn, 2009; Hora, Ferrare, & Oleson, 2012; National Research Council, 2012). As a result, numerous editorials and reports call for increased action to translate educational research and innovation into teaching practice (e.g., ASEE, 2012; Fincher, 2009; President's Council of Advisors on Science and Technology, 2012; Watson, 2009).

Previous research on instructors' decisions about their teaching practices (Felder & Brent, 1996; Finelli, Daly, & Richardson, 2014; Froyd, Borrego, Cutler, Henderson, & Prince, 2013; Henderson & Dancy, 2009; Prince, Borrego, Henderson, Cutler, & Froyd, 2013) has identified several barriers to adoption of active learning, including concerns about student resistance, the efficacy of the techniques, preparation time, and ability to cover the syllabus. Although instructor concerns about the efficacy of active learning are a legitimate barrier, this efficacy has been documented exhaustively (e.g., Freeman et al., 2014; Prince, 2004; Prince & Felder, 2007). Similarly, instructor concerns about both preparation and class time have been convincingly addressed in the literature (Felder, 1992, 1994; Felder & Brent, 2009). However, understanding student resistance as a barrier has not yet been adequately researched. This study focuses on the barrier of student resistance by addressing strategies instructors might use to reduce resistance, and it examines the relationship between students' perceptions of their instructors' use of strategies and students' response to active learning. We used data collected from 1,051 students in 18 introductory engineering courses across the United States to address the following three research questions:

1. *What are students' perceptions about how frequently their instructors used strategies to reduce resistance to active learning?*
2. *What are students' self-reported affective and behavioral*

responses when their instructors used active learning?

3. *What is the relationship between students' perceptions of their instructors' use of strategies to reduce resistance and students' self-reported affective and behavioral responses?*

Literature review

Student resistance

Student resistance, which we define here as students' negative behavioral responses to active learning, has been noted as one of the most frequently mentioned and least researched barriers to instructors' use of active learning (Borrego, Froyd, & Hall, 2010; Finelli et al., 2014; Froyd et al., 2013; Henderson & Dancy, 2009). Students may demonstrate resistance in various ways, such as not participating when asked to engage in an in-class activity, distracting other students, performing the required tasks with minimal effort, complaining, or giving lower course evaluations (Kearney, Plax, & Burroughs, 1991; Seidel & Tanner, 2013; Weimer, 2013).

Researchers have proposed several plausible reasons for resistance, including that active learning might demand more work from students, cause anxiety among students about their ability to perform in the new instructional environment, establish expectations that students are ill-prepared to fulfill, or be a mismatch with students' preferred ways of being taught (Åkerlind & Trevitt, 1999; Alpert, 1991; Keeley, Shemberg, Cowell, & Zinnbauer, 1995; Weimer, 2013). Intentionally using strategies to address these issues could assist instructors in introducing and implementing active learning and could promote the adoption of active learning. Ultimately, overcoming student resistance means that students will participate more and, as the literature has suggested, will learn more.

Strategies to reduce resistance

Researchers and faculty professional development experts have offered a variety of recommendations to reduce student resistance to active learning. Some suggestions include that instructors should clearly explain the purpose and expectations of the activity (Bacon, Stewart, & Silver, 1999; Felder, 2011; Strobel & van Barneveld, 2009; Wilke, 2003), acknowledge the challenges of the new approach (Yadav, Subedi, Lunderberg, & Bunting, 2011), ramp up slowly (Carlson & Winquist, 2011), provide students with feedback and support throughout the process (Bentley, Kennedy, & Semsar, 2011; Felder, 2011; Yadav et al., 2011), align activities with other course assessments (Bentley et al., 2011; Donohue & Richards, 2009), and

TABLE 1

Course demographics.

Course label	Instructor gender	Institution type	Carnegie classification[a]	Course discipline[b]	# Students (n = 1,051)
1	F	Public	R2	CIVIL	31
2	M	Public	R1	INTRO	17
3	F	Public	R1	CBME	131
4	M	Public	R1	DESIGN	51
5	M	Public	M1	ME	27
6	M	Public	R1	EECS	117
7	F	Private	M1	CBME	65
8	F	Public	R1	CBME	41
9	F	Public	BACC	DESIGN	28
10	M	Public	R1	CBME	98
11	F	Private	R2	IDISC	32
12	M	Public	M1	INTRO	162
13	M	Public	M1	ME	26
14	F	Public	R2	CBME	40
15	M	Private	R2	INTRO	94
16	M	Public	BACC	MAT	28
17	F	Private	M1	INTRO	52
18	M	Private	M3	EECS	11

[a]Carnegie classifications: R1 = Doctoral Universities: Highest Research Activity; R2 = Doctoral Universities: Higher Research Activity; M1 = Master's Colleges and Universities: Larger Programs; M3 = Master's Colleges and Universities: Smaller Programs; BACC = Baccalaureate Colleges: Arts & Sciences Focus combined with Baccalaureate Colleges: Diverse Fields.

[b]Course disciplines: CBME = Chemical/Biomedical Engineering; CIVIL = Civil and Environmental Engineering; DESIGN = Design; EECS = Electrical Engineering/Computer Science; IDISC = Interdisciplinary; INTRO = Introduction to Engineering; MAT = Materials Science and Engineering; and ME = Mechanical Engineering.

solicit and act on student feedback about the activities (Felder, 2011; Yadav et al., 2011). There are several ways instructors might implement this advice. For example, instructors might ramp up slowly by using short activities such as “think-pair-share” exercises (Felder, 1992, 1994) before transitioning to more lengthy activities, and they might solicit student feedback using midsemester evaluations or “minute papers” (Felder, 1992). Instructors might address several strategies at once by saying something like the following, paraphrased from Felder (Felder, 2007; Felder & Brent, 2016), as a mini-lecture on the first day of class:

> In this course, I will frequently lecture. But every so often, I will stop lecturing and ask you to answer a question, sometimes on your own, sometimes in groups of two or three. This might feel uncomfortable if it is new for you. That is okay, you’ll quickly get used to it. I want you to know that I’m not doing this as a way to avoid lecturing or as an educational experiment. Those experiments have been run many times. I’m doing this because the research shows that if I do, you will learn more and earn higher grades.

One consistent problem with the advice found in the literature, though, is that it lacks a strong theoretical and empirical base (Bacon et al., 1999; Strobel & van Barneveld, 2009; Wilke, 2003; Yadav et al., 2011). Thus, our research aims to examine how students’ perceptions of their instructors’ use of strategies to reduce resistance relates to their own response to active learning. The results of this work will lead to the development of research-based recommendations for how instructors can reduce student resistance to active learning.

Research methods

Population and setting

During fall 2015 and spring 2016, undergraduate students and instructors in 18 introductory engineering courses across the United States (each at a different institution and each having a different instructor) participated in our study. These instructors self-selected and identified with using active learning instruction in the courses we studied. Although we were not present to observe all 18 courses, these instructors reported using active learning during end-of-course interviews we conducted, and our in-class observations in a prior study confirmed such instructor self-reports (Shekhar et al., 2015).

Data regarding the instructor and course demographics are included in Table 1. This sample represents a mix of instructor gender, institution type, Carnegie classification, and engineering discipline. A total of 1,051 undergraduate students, most of whom were in the first or second year of their engineering studies, participated in our project (range = 11 to 162 students/course, $M = 58.4$ students/course).

Survey instrument

This project involves our Student Response to Instructional Practices (StRIP) instrument, a survey we developed to measure students’ response (both positive and negative) to different types of teaching methods. The end-of-term StRIP instrument (DeMonbrun et al., 2017) includes multiple Likert-scale items (each presented on a 5-point scale; see Table 2 for more information). These items assess the type of instruction used in the class, students’ perceptions of strategies used by the instructor to reduce resistance, and student response to instruction. We used rigorous instrument development procedures to design the survey (including content expert review, cognitive interviews, and testing with over 100 students), we piloted it with four introductory engineering courses, and we conducted this full-scale study with 18 introductory engineering courses from a range of institutions. During our multiphase project, we combined qualitative methods (classroom observations, student interviews, and instructor interviews) with quantitative data from the StRIP instrument and a similar instructor survey. Among our earlier findings from the full-scale study:

- The most commonly reported types of active learning involve in-class discussion and problem solving (Nguyen, DeMonbrun, Borrego, Prince, et al., 2017).
- Student resistance to active learning is not common, and when it does happen, resistance generally manifests as passive classroom behaviors (Nguyen, Husman, et al., 2017).
- It is challenging to characterize instructional practice in ways that align with student resistance (Nguyen, DeMonbrun, Borrego, Husman, et al., 2017).
- Strategies to reduce resistance have a greater influence on student resistance than do students’ expectations for and experiences with different types of instruction (Nguyen, Husman, et al., 2017).

For our present study, we focus on two sections of the StRIP instrument: (a) strategies to reduce resis-

TABLE 2

Descriptive statistics of strategies to reduce resistance and student response.

	M	*SD*
Strategies to reduce resistance		
Explanation[a]	*4.06*	*0.82*
Clearly explained the purpose of the activities.	4.05	0.93
Discussed how the activities related to my learning.	4.01	0.95
Clearly explained what I was expected to do for the activities.	4.13	0.90
Facilitation[a]	*3.64*	*0.85*
Encouraged students to engage with the activities through his/her demeanor.	3.99	1.05
Invited students to ask questions about the activities.	4.03	1.06
Walked around the room to assist me or my group with the activity, if needed.	3.74	1.30
Confronted students who were not participating in the activities.	2.92	1.28
Solicited my feedback or that of other students about the activities.	3.51	1.20
Affective response		
Value[b]	*3.82*	*0.93*
I felt the time used for the activities was beneficial.	3.59	1.16
I saw the value in the activities.	3.78	1.08
I felt the effort it took to do the activities was worthwhile.	3.46	1.14
I planned to give the instructor a lower course evaluation because of the activities.[r]	1.58	1.02
Positivity[b]	*3.72*	*0.88*
I enjoyed the activities.	3.19	1.16
I disliked the activities.[r]	2.22	1.14
I felt positively toward the instructor because of the activities.	3.58	1.15
I complained to other students about the activities.[r]	2.06	1.25
I felt the instructor had my best interests in mind when asking me to do the activities.	4.12	1.01
Behavioral response		
Participation[b]	*3.96*	*0.81*
I tried my hardest to do a good job with the activities.	3.76	1.12
I gave the activities minimal effort.[r]	2.10	1.12
I participated actively (or attempted to) in the activities.	3.90	1.01
I did not actually participate in the activities.[r]	1.75	0.97
Distraction[b]	*2.16*	*0.76*
I surfed the internet, checked social media, or did something else instead of doing the activities.	2.05	1.16
I distracted my peers during the activities.	1.72	0.99
I pretended to participate in the activities.	1.85	1.06
I talked with classmates about other topics besides the activities.	2.83	1.16
I rushed through the activities.	2.35	1.04
Evaluation[c]	*3.55*	*1.11*
Overall, the instructor was an excellent teacher.	3.66	1.19
I would recommend this instructor to other students.	3.56	1.29
Overall, this was an excellent course.	3.40	1.22

[a]In this course, when the instructor asked you to do in-class, nonlecture activities (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).
[b]In this course, when the instructor asked you to do in-class, nonlecture activities (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).
[c]Please rate your level of agreement with the following items (1 = *strongly disagree;* 2 = *disagree*; 3 = *neutral*; 4 = *agree*; 5 = *strongly agree*).
[r]Reverse-coded items—raw data is listed for these individual items (so low numbers mean more positive responses), and scores were reversed before computing factor scores.

tance and (b) student response to instruction.

Strategies to reduce resistance

This section of our StRIP instrument contains 10 items pertaining to students' perceptions about strategies their instructors could use to reduce student resistance to active learning. These items were derived from suggestions provided in the literature, observations we conducted of four large engineering courses (Nguyen, Husman, et al., 2017), and our initial pilot study. We conducted exploratory factor analysis, and because factor loadings for two items were unacceptably low (Comrey & Lee, 1992), we dropped these items from our list of strategies. We grouped the remaining eight items into two factors: *explanation* and *facilitation*. We computed factor scores using the average scores method (Comrey & Lee, 1992); factor loadings ranged from 0.51 to 0.88; and the reliability coefficients for the two factors were 0.87 and 0.77, respectively. These two factors and their subitems are presented in Table 3.

Student response to instruction

This section of our StRIP instrument comprises 19 items that address a range of student responses based on Weimer's (2013) model of student resistance; Chasteen's (2014) model for student engagement; and Fredricks, Blumenfeld, and Paris's (2004) concept of school engagement. In addition, because fear of negative course evaluations has been noted as an important barrier to adoption of active learning, we included three additional items for course and instructor evaluation. We conducted an exploratory factor analysis, and we dropped one item because of a low factor loading. We grouped the remaining 21 items into five factors—two comprise affective responses to instruction (*value* and *positivity*) and three represent behavioral responses (*participation, distraction*, and *evaluation*). We computed factor scores using the average scores method, factor loadings ranged from 0.49 to 0.88, and the reliability coefficients exceed 0.70 for all five factors. These five factors and their subitems are presented in Table 3.

Quantitative research design

We answered our research questions using quantitative methods by analyzing descriptive statistics (*M* and *SD*), tests for significance, correlations, and hierarchical linear regression models (Tabachnick, Fidell, & Osterlind, 2001) with the three behavioral response factors (*participation*, *distraction*, and *evaluation*) as dependent variables. Because of a violation of normality in the data set, the three dependent variables were transformed before doing hierarchical linear regression analyses in *R*: *participation* scores (skewness = –0.77, kurtosis = 0.27) were cubed, *distraction* scores (skewness = 0.87, kurtosis = 0.75) were log-transformed, and *evaluation* scores (skewness = –0.27, kurtosis = –0.80) were squared. After transformation, all dependent variables met regression criteria for normality, linearity, homoscedasticity, and independence (Tabachnick et al., 2001). Because each of our variables followed a normal distribution and the mean scores for each of our factors had at least 11 unique values, we chose to treat all variables as continuous rather than ordinal (Nunnally & Bernstein, 1994).

To determine the unit level of analysis, we first calculated the intraclass correlation coefficient (ICC) to measure the total amount of variance that could be explained by an association with a group (i.e., the amount of variation across courses, rather than within them). The ICC values for each of our dependent variables were below 0.20, indicating that less than 20% of the variance in these variables was between courses (Hox, 2002). Thus, we conducted all analyses using a single-level hierarchical linear regression model at the student level.

Results

To answer our first research question (*What are students' perceptions about how frequently their instructors used strategies to reduce resistance to active learning*?), we analyzed descriptive statistics for each of the eight strategies to reduce resistance from our StRIP instrument and for the two *explanation* and *facilitation* factors (Table 2). The strategy that students perceived their instructors used most frequently (M = 4.13) was "clearly explained what I was expected to do for the activities," whereas the strategy students perceived their instructors used least frequently (M = 2.92) was "confronted students who were not participating in the activities." Students perceived that *explanation* strategies were used more frequently than *facilitation* strategies (M = 4.06 vs. 3.64), and this difference was statistically significant (Welch two-sample t-test, $t[2104] = 11.56$, $p \leq .001$).

To triangulate with student perceptions, we also administered an instructor version of the StRIP instrument to the 18 instructors in our project to assess the frequency with which they reported using *explanation* and *facilitation* strategies. Students' perceptions and instructors' reports of *explanation* strategies (M = 4.06 vs. 3.85, Welch two-sample t-test, $t[17] = –0.87$, = .40; $d = 0.21$) and *facilitation* strategies (M = 3.64 vs. 3.93, Welch two-sample t-test, $t[17] = 1.79$, = .09; $d = –0.42$)

TABLE 3

Factor loadings and reliabilities.

	alpha	Loading
Explanation (3 items)	*0.87*	
Clearly explained the purpose of the activities.		0.88
Discussed how the activities related to my learning.		0.78
Clearly explained what I was expected to do for the activities.		0.77
Facilitation (5 items)	*0.77*	
Encouraged students to engage with the activities through his/her demeanor.		0.73
Invited students to ask questions about the activities.		0.70
Walked around the room to assist me or my group with the activities, if needed.		0.69
Confronted students who were not participating in the activities.		0.51
Solicited my feedback or that of other students about the activities.		0.54
Affective response		
Value (4 items)	*0.87*	
I felt the time used for the activities was beneficial.		0.88
I saw the value in the activities.		0.87
I felt the effort it took to do the activities was worthwhile.		0.76
I planned to give the instructor a lower course evaluation because of the activities.[r]		−0.60
Positivity (5 items)	*0.83*	
I enjoyed the activities.		0.75
I disliked the activities.[r]		−0.74
I felt positively toward the instructor because of the activities.		0.72
I complained to other students about the activities.[r]		−0.67
I felt the instructor had my best interests in mind when asking me to do the activities.		0.57
Behavioral response		
Participation (4 items)	*0.78*	
I tried my hardest to do a good job with the activities.		0.69
I gave the activities minimal effort.[r]		−0.69
I participated actively (or attempted to) in the activities.		0.66
I did not actually participate in the activities.[r]		−0.63
Distraction (5 items)	*0.74*	
I surfed the internet, checked social media, or did something else instead of doing the activities.		0.70
I distracted my peers during the activities.		0.65
I pretended to participate in the activities.		0.59
I talked with classmates about other topics besides the activities.		0.49
I rushed through the activities.		0.51
Evaluation (3 items)	*0.89*	
Overall, the instructor was an excellent teacher.		0.87
I would recommend this instructor to other students.		0.87
Overall, this was an excellent course.		0.77

[r]Reverse coded items—raw data is listed for these individual items (so low numbers mean more positive responses), and scores were reversed before computing factor scores.

varied, but the difference was not statistically significant. Our results provide no evidence that faculty reports of the usage of strategies to reduce resistance to active learning were different from students' perceptions.

To answer our second research question (*What are students' self-reported affective and behavioral responses when their instructors used active learning*?), we analyzed descriptive statistics for the 21 items about student response to instruction and the five factors of *value*, *positivity*, *participation*, *distraction*, and *evaluation* (Table 2). The most frequently experienced student responses (M = 4.12 and 3.90, respectively) were "I felt the instructor had my best interests in mind when asking me to do the activities" and "I participated actively (or attempted to) in the activities." The least frequently experienced responses (M = 1.58, 1.72, and 1.75, respectively) were "I planned to give the instructor a lower course evaluation because of the activities," "I distracted my peers during the activities," and "I did not actually participate in the activities." On average, students reported that they *valued* the in-class activities often (M = 3.82), were *positive* about them often (M = 3.72), *participated* often (M = 3.96), and were seldom *distracted* (M = 2.16) when doing in-class activities. Students *evaluated* the course and instructor highly (M = 3.55).

To answer our third research question (*What is the relationship between students' perceptions of their instructors' use of strategies to reduce resistance and students' self-reported affective and behavioral responses*?), we computed bivariate Pearson correlations between the two strategies to reduce resistance (*explanation* and *facilitation*) and the five student response to instruction factors (*value*, *positivity*, *participation*, *distraction*, and *evaluation*; Table 4). All relationships were statistically significant ($p \leq .001$), and the magnitude of the correlation coefficients (or effect sizes) ranged from 0.22 to 0.86, suggesting low to high strength (Cronbach, 1951). Thus, students' perceptions of their instructors' use of either *explanation* or *facilitation* strategies is positively (and significantly) related to higher *value*, more *positivity*, greater *participation*, less *distraction*, and higher *evaluation*.

Next, we conducted three separate hierarchical linear regression models (one for each of the three behavioral responses: *participation, distraction,* and *evaluation*) to understand whether strategies to reduce resistance (*explanation* and *facilitation*) and students' affective responses (*value* and *positivity*) predicted students' behavioral responses. Hierarchical linear regression models incorporate predictor variables in a stepwise fashion to allow for comparison between standardized beta coefficients (β) and the amount of variance explained in each model. For our analysis, in the first step, we only included the strategies (*explanation* and *facilitation*) as independent variables for each of our three models, and then in the second step we added the affective responses (*value* and *positivity*) as predictors. The regression coefficients (B) and their standard error ($SE\ B$) indicate the strength of the relationship (i.e., the effect size) between each independent variable and the dependent variable (i.e., behavioral responses), and we standardized those values (β) in our analyses. Table 5 shows the results of our analyses.

As shown in Table 5, all three models were statistically significant ($p \leq .05$ with corresponding F-test) in the first step, and in each model, both the *explanation* and *facilitation* factors were significant predictors ($p \leq .05$) of students' behavioral responses. Although both the *explanation* and *facilitation* factors had a significant

TABLE 4

Pearson correlation between strategies to reduce resistance and student response.

		Stategies to reduce resistance		Affective response		Behavioral response	
		1	2	3	4	5	6
Strategies to reduce resistance							
1	*Explanation*	–					
2	*Facilitation*	0.59	–				
Affective response							
3	*Value*	0.48	0.55	–			
4	*Positivity*	0.51	0.58	0.86	–		
Behavioral response							
5	*Participation*	0.26	0.30	0.56	0.54	–	
6	*Distraction*	–0.22	–0.25	–0.43	–0.46	–0.60	–
7	*Evaluation*	0.39	0.43	0.54	0.60	0.27	–0.27

$p \leq .001$ for all correlations.

relationship with each of the three types of behavioral response, the *facilitation* items had a larger effect (i.e., larger β) on the strength of the relationship. However, students perceived that *facilitation* strategies were used less often than *explanation* (as indicated in Table 2). Additionally, these two factors explained a sizeable portion of the variation in the outcomes for one of the three hierarchical linear regression models (*evaluation*) with an R^2 statistic of 0.21.

In the second step, also shown in Table 5, all three models were again statistically significant ($p \leq .05$ with corresponding F-test). For each model, the R^2 statistic increased (e.g., from 0.21 to 0.32 for *evaluation*), indicating that additional variance was explained by the inclusion of *value* and *positivity* as independent variables. However, for the *participation* and *distraction* models, *value* was the only significant predictor (i.e., *explanation* and *facilitation* are no longer significant). *Value* also had the largest effect on *evaluation* (largest β at 0.23), even though all four independent variables were significant predictors ($p \leq .05$). This suggests that whether students *value* active learning mediates the relationship between student perceptions of their instructors' use of strategies to reduce resistance and students' behavioral response.

Finally, to better demonstrate the way levels of *explanation* and *facilitation* influence student evaluations of the course and the instructor, we studied how *evaluation* changed when students perceived different levels of the two types of strategies to reduce resistance (Table 6). Each cell in that table includes the average *evaluation* score provided by students who perceived that their instructor used *explanation* and *facilitation* strategies to the extent listed along the axes.

Table 6 shows that instructors whose students perceived they had a greater use of *explanation* or *facilitation* strategies benefited from higher student *evaluation* scores, and the highest *evaluation* scores came when students perceived that their instructors used both *explanation* and *facilitation* strategies often. For example, an instructor in the lowest quartile in both strategies would expect, on average, that students would slightly disagree (M = 2.70) with the *evaluation* statements (e.g., "Overall, this was an excellent course"). Keeping one variable the same and improving to the fourth quartile in either *explanation* or *facilitation* would be likely to result in approximately a one-point increase (M = 3.76 for

TABLE 5

Hierarchical linear regression models predicting behavioral response from perceived use of strategies to reduce resistance and affective response.

Independent variable	Dependent variable								
	Participation			*Distraction*			*Evaluation*		
	B	*SE*	*β*	*B*	*SE*	*β*	*B*	*SE*	*β*
Step 1:									
Explanation	6.01	1.57	0.14*	–0.05	0.02	–0.12*	1.90	0.33	0.21*
Facilitation	9.00	1.52	0.22*	–0.07	0.02	–0.18*	2.74	0.31	0.31*
Constant	12.06	5.50		1.19	0.05		–3.92	1.14	
R^2	0.11			0.09			0.21		
F	62.69*			48.76*			137.79*		
Step 2:									
Explanation	0.19	1.46	0.01	–0.01	0.02	–0.03	0.86	0.32	0.09*
Facilitation	–0.33	1.45	–0.01	–0.01	0.02	–0.03	1.25	0.32	0.14*
Value	20.15	1.70	0.53*	–0.15	0.02	–0.41*	1.86	0.38	0.23*
Positivity	1.91	2.68	0.03	0.01	0.03	0.01	2.66	0.61	0.20*
Constant	–13.58	6.13		1.37	0.07		–10.49	1.35	
R^2	0.32			0.20			0.32		
F	114.34*			60.80*			215.47*		

*$p \leq .05$.

higher *explanation* and *M* = 3.77 for higher *facilitation*); while improving to the fourth quartile in both *explanation* and *facilitation* would be likely to result in the strongest level of agreement (*M* = 4.25) with the *evaluation* statements.

Discussion

This study examined student perceptions of their instructors' use of strategies to reduce resistance in 18 introductory engineering courses that used active learning instruction. These strategies represent two basic categories: *explanation* and *facilitation*. *Explanation* strategies are those in which the instructor describes the purpose of the activities and discusses why the activities are valuable, and *facilitation* strategies are those in which the instructor interacts with students or encourages students to engage. In response to our specific research questions, we note three main findings.

First, students in our data set perceived that their instructors used *explanation* strategies more frequently than *facilitation* strategies. The strategy students perceived to be used most frequently was to "clearly explain what students were expected to do for the activities," and the one perceived to be used least frequently was to "confront students who were not participating in the activities." Students perceived three *facilitation* strategies (walk around the room to assist students, confront students who are not participating, and solicit student feedback about the activities) to be underused compared with the other strategies.

Second, we found little resistance to active learning among students in our data set. Students, on average, reported that they sometimes or often *participated* in active learning instruction, often *valued* and felt *positive* about the activity, seldom were *distracted*, and often *evaluated* the course/instructor highly. The most frequently reported response to active learning was to "feel the instructor had the students' best interest in mind when asking students to do the activity," and the least frequently reported response was to "plan to give the instructor a lower course evaluation because of the activities."

Third, students' perceptions of their instructors' use of both *explanation* and *facilitation* strategies was significantly correlated with improvements in all three measures of students' behavioral response to active learning, including greater *participation* and less *distraction* during the activity and higher overall *evaluation* of both the instructor and course. Whether students *valued* the active learning instruction was an even stronger predictor of these outcomes. Relatively high correlation between *explanation*, *facilitation*, and *value* suggests that future work should investigate whether these strategies reduce resistance to active learning by increasing *value*.

There are several findings here of interest to the faculty development community. First, it should be noted that the reported levels of student resistance to active learning exhibited in these 18 classes were quite low. Although the data suggests that student resistance is real, the majority of the students in this large data set responded positively to active learning instruction. This is an important finding for instructors who are concerned that the dominant student response to active learning will be negative, and it is a message that should be broadly disseminated to instructors to help lower the barrier to adoption of active learning.

In addition, the data suggests that students' response to active learning instruction can be significantly improved by promoting the perception of using specific strategies to reduce resistance. Although this study did not directly measure actual instructor use of such strategies, certainly one possible way for an instructor to increase students' perception is to actually use

TABLE 6

Average evaluation score within each explanation and facilitation quartile.

Explanation	***Facilitation***			
	First quartile (*n* = 343)	**Second quartile (*n* = 231)**	**Third quartile (*n* = 209)**	**Fourth quartile (*n* = 269)**
Fourth quartile (*n* = 254)	3.76 (*n* = 17)	3.98 (*n* = 31)	4.02 (*n* = 60)	4.25 (*n* = 146)
Third quartile (*n* = 196)	3.63 (*n* = 29)	3.70 (*n* = 63)	3.72 (*n* = 45)	3.72 (*n* = 50)
Second quartile (*n* = 336)	3.21 (*n* = 128)	2.99 (*n* = 89)	3.15 (*n* = 74)	3.90 (*n* = 45)
First quartile (*n* = 266)	2.70 (*n* = 169)	2.99 (*n* = 48)	3.15 (*n* = 30)	3.77 (*n* = 19)

the strategy and another way is to explicitly communicate to students what they are doing and why. In particular, because students perceive that *facilitation* strategies are used less often, but these strategies may be more effective at reducing resistance than *explanation* strategies, this message should be more heavily promoted by the faculty development community.

This study has some limitations worth noting. First, the data are based on student surveys, so although the student responses match faculty self-reports, the data rely on students' interpretations and recollections of their own and their instructors' behaviors. Although direct observations of these classrooms would have triangulated student and faculty reports, student resistance involves many types of response that cannot necessarily be observed by others. This is particularly true for affective responses of *value* and *positivity*.

Our quantitative research design was performed at the student level, and this is perhaps another key limitation. Because only 18 courses were analyzed and because the ICC values were less than 0.20, a class-level analysis such as a hierarchical linear model (HLM) was not recommended. The low ICC values mean that much of the variation in the data set was not *between* the 18 courses but *within* the courses, as students within a specific course had different perceptions of their instructors' use of strategies to reduce resistance and therefore responded differently. There are several plausible explanations for these within class differences. It could mean that instructors did not treat all students the same way (perhaps not all students were actually confronted) or that instructors did treat the students uniformly but not all students attended class or noticed what was happening. For example, when students were engaged in an activity, they might not have noticed that the instructor was inviting other students to ask questions. Another possibility is that the way we worded our survey items (*When the instructor asked you to do in-class, nonlecture activities, how often did the instructor do the following things*?) allowed students to focus on different instances when the instructor used active learning.

Another limitation of this project is that the participating instructors are a sample of convenience chosen from volunteers. It is likely that instructors willing to volunteer to have their classes examined as part of a formal research project are experienced and comfortable using both active learning instruction and strategies to reduce resistance. Care should therefore be taken in extrapolating these results, especially those related to average measures of student resistance, to classes where instructors are using active learning instruction for the first time.

Conclusion

This study is one of very few that presents data on how engineering undergraduate students respond to active learning instruction, and it is perhaps the first to present empirical data about how student perceptions of their instructors' use of strategies to reduce resistance can influence student engagement with active learning and evaluation of the course and instructor. Our results lend additional credence to anecdotal advice from the literature, and they provide a more complete picture of the relative efficacy of *explanation* and *facilitation* strategies. Most important, our results confirm that how students respond to active learning, and how students evaluate the course and instructor are related to students' perceptions of their instructors' use of strategies to reduce resistance. Our results also indicate that students' perceptions of *facilitation* strategies have a stronger relationship with reducing student *distraction*, increasing *participation*, and improving overall *evaluation* of the instructor and course than do *explanation* strategies. The relationships presented here provide evidence-based advice for both new and experienced instructors to reduce resistance to active learning. ■

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