A Faculty Learning Community to Improve Teaching Practices in Large Engineering Courses: Lasting Impacts

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Background and Overview

Student-centered teaching practices are known to have a positive impact on student success. There is increasing evidence that using techniques such as active learning in the classroom and working to increase student motivation can improve student learning, knowledge retention, and persistence (9, 10). Despite the large body of research supporting these effective teaching practices, there are several barriers to faculty's adoption of them. Such barriers include, but are not limited to, lack of familiarity with the practices, inadequate time to apply new teaching practices to their courses, and the possibility of student resistance (1, 4, 7).

In order to support engineering faculty in adopting effective teaching practices, we designed and implemented the "Teaching Circle for Large Engineering Courses". This instructional development program provides faculty with research evidence and a support community as a way to overcome possible barriers to incorporating student-centered teaching practices into the classroom. The Expectancy-Value Theory (EVT) of motivation (2, 3) offered a theoretical framework to interpret data we collected from our own faculty about factors that influence their motivation to adopt effective teaching practices (4). We used that data to ground the development of our Teaching Circle.

We also integrated Wlodkowksi's (12) five elements of adult learner motivation into the design of our Teaching Circle. We did this by 1) including facilitators with **expertise** in engineering instruction, 2) including facilitators who were trained as engineers and able to provide research **relevant** to effective teaching practices and learning theory for large engineering courses, 3) introducing a range of effective teaching practices, so faculty were able to **apply** and adopt teaching strategies in which they were most comfortable with, 4) allowing time for **reflection** on faculty's individual teaching practices while subsequently incorporating **active discussion** with fellow engineering participants and facilitators to gain further perspective, and 5) building a sense of community by collaborating with fellow engineering participants and facilitators through **group work**.

To assess the impact of our Teaching Circle, we utilized Murray's Teaching Behavior Inventory (TBI) (8) and Trigwell and Prosser's Approaches to Teaching Inventory (ATI) (11). These are validated instruments that measure key aspects about behaviors and approaches towards teaching. In this paper, we share findings about the long-term effectiveness of the Teaching Circle on participants' teaching practices. Specifically, we compare participants' TBI and ATI data before and after participating in the Teaching Circle for three separate offerings of the program, and we follow the participants over time to collect longitudinal data. We also contrast these data with similar data from a control group of faculty.

Teaching Circle Design and Methods

This paper expands upon a previous report assessing the first offering of the Teaching Circle (5) by presenting additional data from two subsequent offerings of the program. For all three offerings, the Teaching Circle had the same format. The program was led by two facilitators - an experienced instructional developer and a respected engineering faculty member. It consisted of four, two-hour sessions over one academic term which addressed student rapport in large classes, active learning techniques, student motivation and screencasts, student pre-/mis-conceptions and classroom response systems. The monthly sessions incorporated readings on relevant research, discussion amongst the participants and with other senior faculty dedicated to their teaching, and practical strategies for success. Participants were invited to have a midterm student feedback session to assess the impact of their efforts and identify strategies to respond to student data (6), and they were encouraged to visit the classes of other effective teachers. Upon completion of the program, participants were eligible for a $1,000 grant to support their teaching in large courses.

Engineering faculty were invited to apply to the Teaching Circle, and the facilitators selected six to seven faculty participants per term (total n=19). Participants were representative of the college faculty in terms of range of rank, engineering discipline, experience level, and familiarity with effective teaching practices. Additionally, faculty who applied to participate in the Teaching Circle, but who were not selected, were asked to serve as a control group, and several of them agreed to serve in that capacity (total n=12).

The impact of the Teaching Circle was measured by using Murray's Teaching Behavior Inventory (TBI) (8) and Trigwell and Prosser's Approaches to Teaching Inventory (ATI) (11), validated instruments that measure key aspects about behaviors and approaches towards teaching. The TBI consists of low-inference teaching behavior items categorized into six meta-behaviors including: 1) **enthusiasm**, 2) **clarity**, 3) **interaction**, 4) **task orientation**, 5) **rapport**, and 6) **organization**. The ATI is a short inventory that measures two key aspects about the way an instructor approaches his/her teaching - half of the inventory addresses **instructor-focused** teaching approaches and the other half addresses **student-focused** approaches. Prior to the initial Teaching Circle meeting, participants were asked to complete the TBI and the ATI instruments, allowing us to collect measures of the six self-reported teaching behaviors and the two approaches to teaching (pre-survey). Altogether, pre-survey data includes indicators of eight items: enthusiasm, clarity, interaction, task orientation, rapport, and organization, and instructor-focused and student-focused approaches to teaching.

At the end of the term, immediately following participation in the Teaching Circle, faculty completed the TBI and ATI again (post-survey 1). Additionally, to assess longitudinal impact of the program, participants completed both inventories at up to three subsequent times (post-survey 2, 3, and 4) at the beginning and end of subsequent semesters, resulting in up to four post-survey data points for each participant. After comparing the post-survey 1 and post-survey 2 scores and finding no significant difference ($p > 0.05$), we averaged all post-survey scores to compute a *post-survey index* for each individual participant. Faculty in the control group also completed the TBI and ATI at the beginning of one semester (pre-survey), at the end of that same semester (post-survey 1) and up to three later points at the beginning and end of subsequent semesters (post-survey 2, 3, and 4). We similarly computed a post-survey index for each member of the control group.

To assess the impact of the Teaching Circle, we conducted three separate analyses. Results were considered *significant* at $p < 0.05$ and *marginally significant* when $0.05 < p < 0.10$ for all analyses.

- *Analysis 1*: First, we studied changes in faculty's behaviors and approaches towards teaching for Teaching Circle participants. We compared the post-survey index to the pre-survey score for all eight items using a Paired T-test. We conducted a similar comparison for the control group.

- *Analysis 2*: Second, for every individual in both the intervention and control group, we computed an average difference (gain or loss) for each of the eight items by subtracting the pre-survey score from the post-survey index. Then we conducted an independent T-test to compare the average differences (gains or losses) of the intervention and control groups.

- *Analysis 3*: Third, to study lasting impacts for Teaching Circle participants, for all eight items, we applied a Simple Linear Regression to the series of up to four difference scores (i.e. post-survey 1 minus pre-survey, post-survey 2 minus pre-survey, etc. for as many as four post-surveys). The regression modeled the general pattern of differences (gains or losses) in teaching behavior and approaches over time.

Results

Analysis 1: Our first analysis showed that the Teaching Circle had a positive effect on the participants' teaching behavior (Figure 1). The Teaching Circle participants showed a *significant* increase in self-reported **enthusiasm**, **clarity**, and student **interaction** behaviors from the pre-survey to the post-survey index following participation in the Teaching Circle ($p = 0.002$, 0.003, and 0.004, respectively), while they showed a *marginally significant* increase in **rapport** ($p = 0.08$) (Figure 1). Although differences in **orientation** and **organization** were *not significant*, there was a slight increase in self-reported score from the pre-survey to the post-survey index. The control group showed no significant gains or losses in any of the TBI scores (all p-values > 0.15) (Figure 1).

Although not significant, participants in the Teaching Circle also showed a slight increase in **student-focused** teaching approaches, while they showed no change in the **instructor-focused** approaches (all p-values > 0.45) (Figure 2). The control group also did not demonstrate any changes in teaching approaches as measured by the ATI (all p-values > 0.20) (Figure 2).

Figure 1. Average pre-survey and post-survey index scores for TBI items of intervention (n=19) and control (n=12) groups.
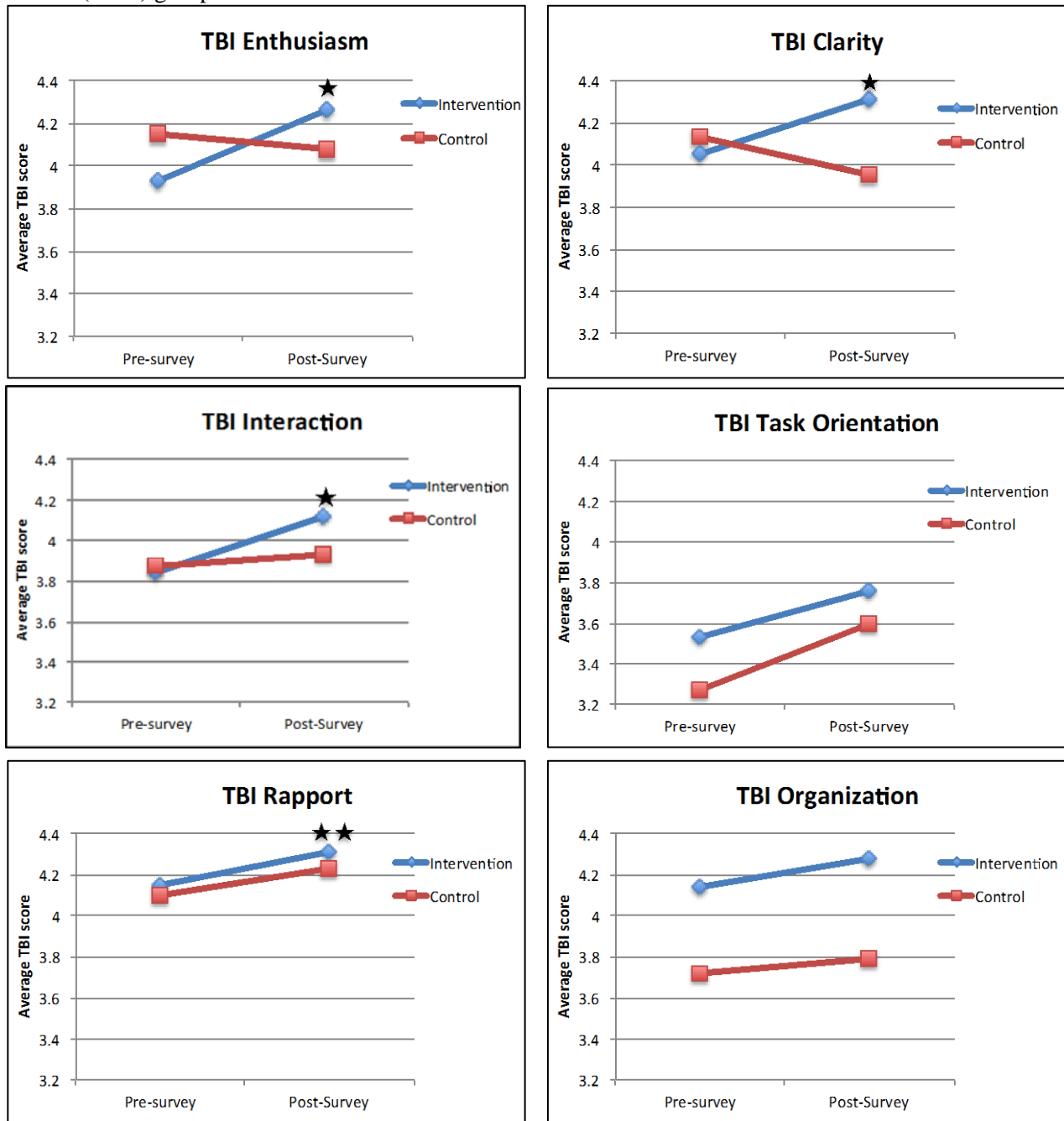
* *Significant* change (p<0.05) from the pre-survey to the post-survey index within the intervention or control group, measured by a Paired T-test.

** *Marginally significant* change (0.05 < p < 0.10) from the pre-survey to the post-survey index within the intervention or control group, measured by a Paired T-test.

Figure 2. Average pre-survey and post-survey index scores for ATI items of intervention (n=19) and control (n=12) groups.
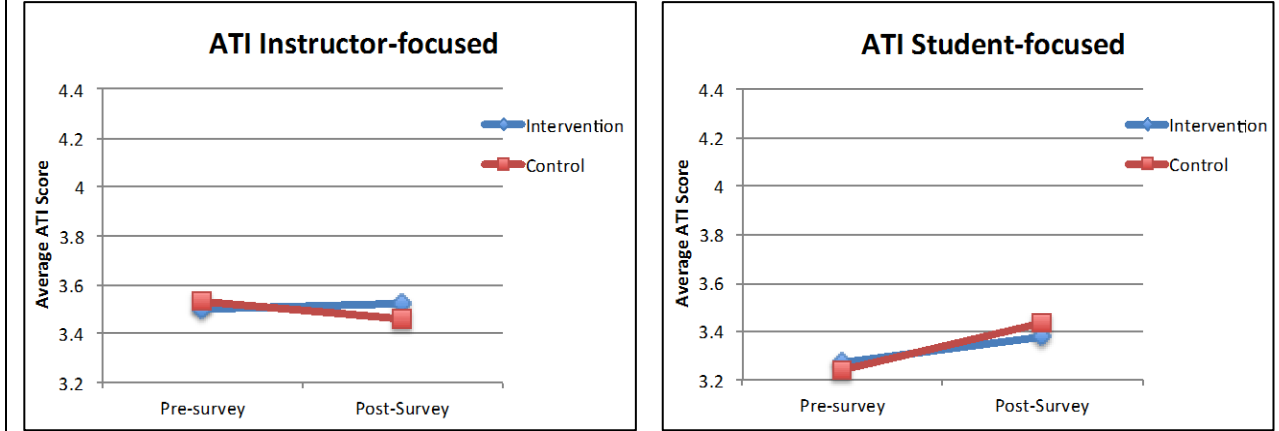
Analysis 2: For our second analysis, we found that participants in the Teaching Circle exhibited higher gains in teaching behavior compared to the control group. The intervention group displayed *significantly* higher gains in **enthusiasm** and **clarity** when compared to the control group (p = 0.003 and 0.03, respectively) (Table 1). Although not significantly different than the control group, the intervention group showed higher gains in **interaction** and **organization** from the pre-survey to the post-survey index (Table 1). The Teaching Circle did not affect differences in either **instructor-focused** or **student-focused** approaches to teaching from the pre-survey to the post-survey index in the participants compared to the controls (Table 2).

Table 1. Differences (gains or losses) in pre-survey and post-survey index scores for TBI items.

| Group	Enthusiasm	Clarity	Interaction	Task Orientation	Rapport	Organization
Intervention	0.33*	0.26*	0.28	0.23	0.15	0.14
Control	-0.07	-0.18	0.07	0.33	0.16	0.07

* p<0.05 for the intervention group (n=19) compared to the control group (n=12)

Table 2. Differences (gains or losses) in pre-survey and post-survey index scores for ATI items.

| Group	Instructor-focused	Student-focused
Intervention	0.03	0.11
Control	-0.07	0.19

Analysis 3: Finally, our third analysis showed that the **organization** had *significant* gains over time in the intervention group (p = 0.007) while **task orientation** showed a *marginally significant* gain (p = 0.07) (Figure 3). Although *not significant*, **enthusiasm**, **clarity**, and **rapport** showed a pattern of increasing scores over time. Additionally, the scores for **instructor-focused** remained similar over time while **student-focused** teaching approaches increased over time with a slight decrease in the last post-survey (Figure 4).

Figure 3. Average predicted gains for TBI items of intervention (n=19) group.
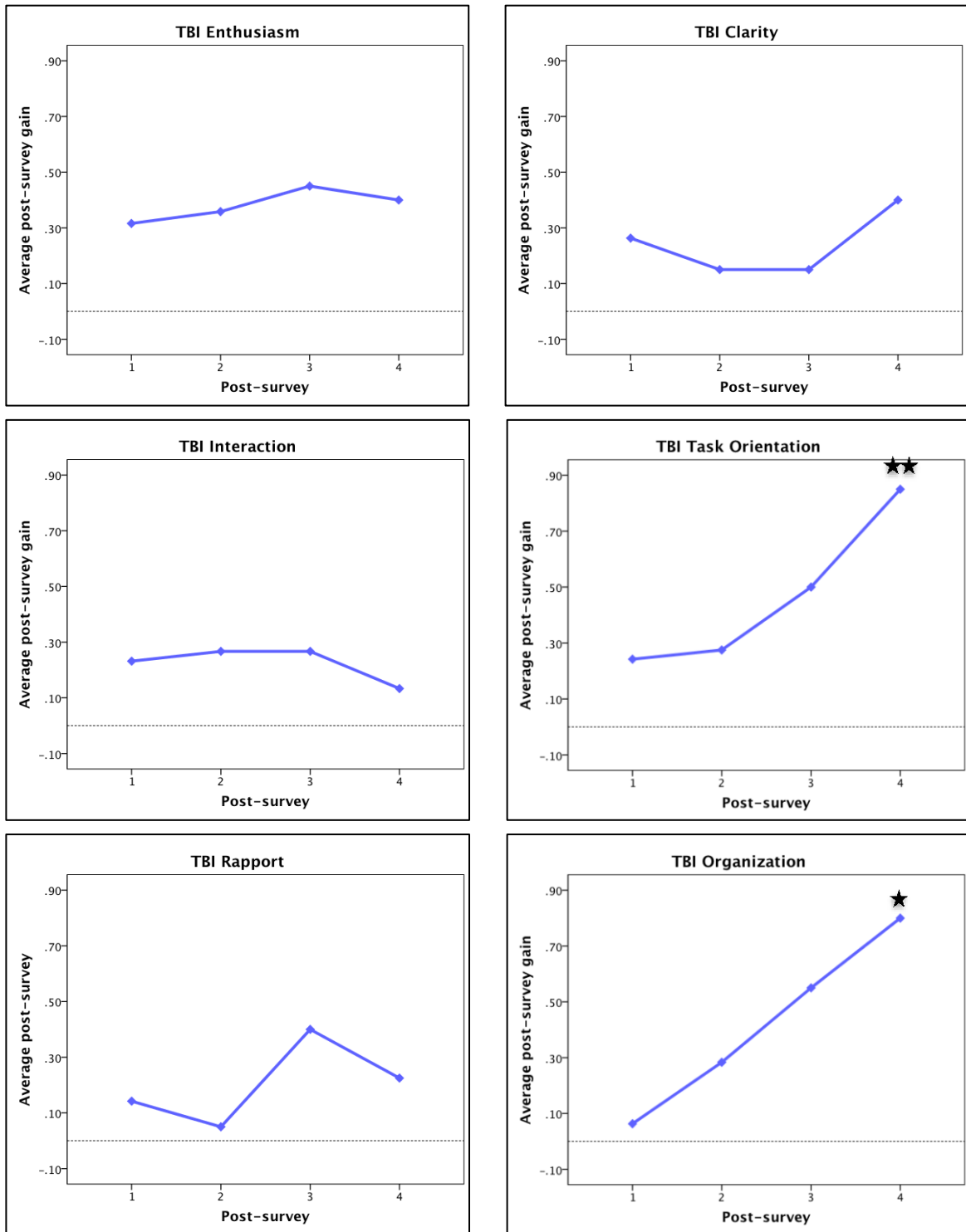
* *Significant* change (p<0.05) of post-survey scores as measured by a Simple Linear Regression.
** *Marginally significant* change (0.05 < p < 0.10) of post-survey scores as measured by a Simple Linear Regression.

Figure 4. Average predicted gains for ATI items of intervention (n=19) group.
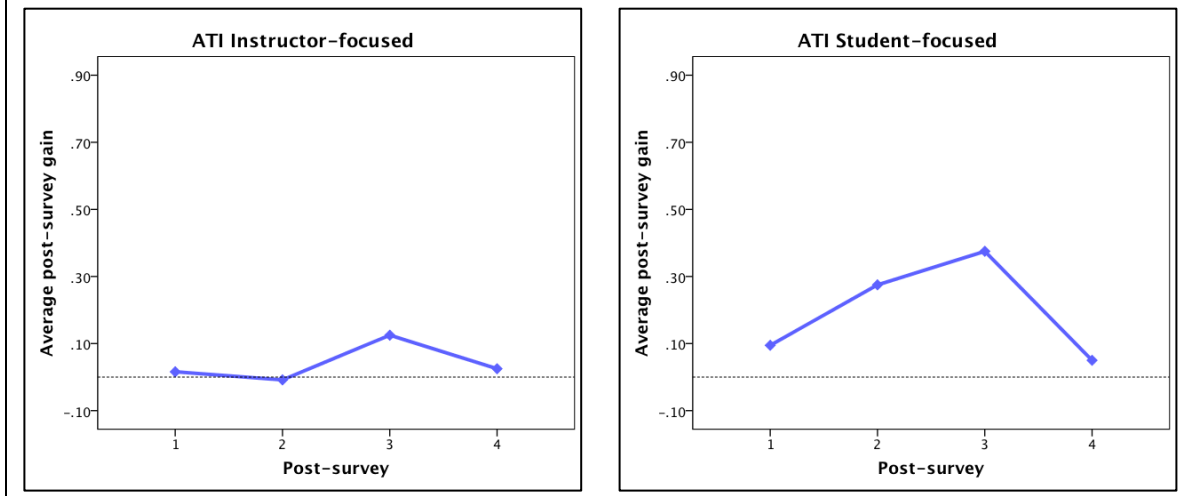
Discussion and Implications

Our data shows that participating in the "Teaching Circle for Large Engineering Courses" positively impacted the behavior and approaches toward teaching of our engineering faculty. Following the Teaching Circle, engineering faculty had an increase in in all six teaching behaviors measured by the TBI. The increase was statistically significant for enthusiasm, clarity, interaction, and rapport (*Analysis 1*). When the differences of the intervention group were compared to the control group, the intervention group displayed significantly higher gains in enthusiasm and clarity (*Analysis 2*).

When we tracked the changes over time, the engineering faculty showed a general increase in organization, task orientation, enthusiasm, clarity, and rapport (*Analysis 3*). Although the data indicate that faculty did not change their instructor-focused approaches over time, they did illustrate a general increase in student-focused teaching approaches up to the third post-survey (Figure 4). Two explanations for the drop in student-focused teaching for the final post-survey include: (1) the small number of faculty with a total of four completed post-surveys (n=4 faculty), and (2) the possibility that the ATI instructor-focused items do not capture the appropriate outcomes designed for this Teaching Circle.

Following engagement in the Teaching Circle, faculty's teaching behavior and approaches towards teaching (specifically their adoption of student-focused teaching approaches), increased immediately after participation and continued to increase or remain increased during consecutive semesters teaching. Additionally, we conducted objective classroom observations at the beginning of the term and again at the end of the term for participants. We found that participants changed their teaching to increase student engagement and active learning. For instance, we observed that one faculty member simply displayed the correct answer to a problem at the beginning of the term but, after completing the program, the same faculty member had students discuss the correct answer to a similar problem. A second faculty member had students work individually to solve quiz problems at the beginning of the term, but asked students to discuss quiz answers with a neighbor at the end of the term. Thus, the program provides a lasting impact on engineering faculty.

Presenting data from three distinctly separate Teaching Circles (each having the same content but a new diverse set of participating faculty and two new expert facilitators), illustrates the ability of our cohort-based program to promote faculty adoption of effective teaching practices. While the context of this study

was specifically our engineering faculty teaching large engineering courses, these efforts can be adapted and generalized to similar contexts and settings, and they can provide a framework for other professional faculty development.

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