The Effects of Professional Development and Coaching on Teaching Practices

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The Effects of Professional Development and Coaching on Teaching Practices of Engineering Faculty

Background and Purpose

This **complete paper** reports on **evidence-based practices**. Beginning in the 2016-17 academic year, engineering faculty, across six disciplines, at a large university in the Southwest began participating in professional development supported by an NSF Improving Undergraduate STEM Education (IUSE) grant. The two-semester sequence of professional development involves biweekly workshops during the first semester and facilitated communities of practice the following semester. The workshops and the communities of practice are discipline-based (e.g., mechanical engineering, civil engineering) with multiple themed discipline-based workshops occurring every other week. The workshops promote student-centered classrooms, encourage faculty to actively use formative feedback to refine teaching and learning, and emphasize the importance of integrating real-world connections. Fundamentally, the goals of the professional development are to promote active learning and student-centered instruction.

Spring 2017 was the second semester of the two-semester sequence and faculty focused on classroom implementation while also participating in discipline-based communities-of-practice. The communities-of-practice sessions focused on themes featured in the workshops, but allowed for more give-and-take, flexibility of topics, and sharing of instructional ideas. Themes included topics such as promoting an inclusive environment, engaging students through collaborative projects, and using formative assessment during class time.

Throughout the academic year, classroom practices of the faculty were evaluated by trained observers using the Reformed Teaching Observation Protocol (RTOP). The RTOP is a 25-item validated observation protocol with sound psychometric properties [1], [2] and it has been utilized in numerous middle school through postsecondary projects [3], [4], [5], [6]. The RTOP focuses on gauging the degree to which learning environments are student-centered in science, engineering, and mathematics. The RTOP consists of 25 items rated on a 0 to 4 scale. Each item is rated based on the degree to which a lesson is reflective of that item. The possible total score range on the RTOP is zero to 100. Example items and discussion of the RTOP constructs are provided in the Methods section.

Complete observation data were available for 26 faculty members who were observed twice early during the Fall 2016 semester (pre-observations) and twice late during the Spring 2017 semester (post-observations). The two pre-observations occurred during the first twelve weeks of the fall semester and post-observations occurred during the last six weeks of the spring semester. It is noted that faculty were also observed twice early during the spring semester, but this study focuses on the changes between the first and last sets of observations.

Because many faculty members became interested in the use of the RTOP and were eager to improve their instructional approaches, an unplanned strategy to support faculty emerged. Twenty-one faculty members requested to receive one-on-one feedback with an observer who was also an experienced K-12 instructional coach. During these coaching sessions, the instructional coach typically honed in on a few RTOP items, provided the faculty member with insight about student engagement, and offered concrete suggestions for improving instructional practices. It is noted that the instructional coach was not a workshop facilitator and had no prior relations with these faculty members.

Consequently, this study had two research objectives. The first was to determine the effects of participating in the professional development. This first purpose was a planned objective from the outset of designing the IUSE professional development program. The second purpose was to determine the effects of receiving coaching, in the context of ongoing professional development, on instructional practices, as measured by the RTOP. This second objective was not originally planned but emerged when it was noted that faculty members were requesting feedback and were seemingly engaged with the ensuing conversations.

Relevant Literature

The value of student-centered instruction has been well document across multiple higher education settings including undergraduate engineering [7], [8], [9]. Evidence indicates that student-centered instruction that engages students in inductive thinking and meaningful discussion about engineering concepts supports learning [10], [11]. Naturally, a question that arises about student-centered pedagogy is whether professional development is an effective way to impact classroom practices. Faulty perceptions may exist that some instructors are simply “born” lecturers while others are innately comfortable with activity-driven learning [12]. Numerous evaluation studies have demonstrated positive impacts of professional development on attitudes regarding student-centered learning. Yet these studies often rely on surveys or interviews, such as Stes, Coertjens, and Petegem [13] who used qualitative interview data to assess the effects of professional development on teaching practices. Similarly, Lattuca, Bergom, and Knight [14] evaluated survey responses from over 900 engineering faculty members in determining the positive effects of professional development on reported use of student-centered teaching practices. However, because some research has raised concern about the mismatch between reported beliefs and actual classroom practices [15], [16] it was important to observe, document, and analyze the extent to which faculty participating in the IUSE professional development were integrating student-centered practices into their classrooms.

We also examined the specific practice of instructional coaching in a college of engineering. Coaching is defined here as observation of a classroom by an instructional expert followed by pointed one-on-one feedback. What we know about the effects of instructional coaching come largely from PreK-12 classrooms. For example, Shidler [17] found that professional development, coupled with instructional coaching, had strong positive effects on the efficacy of teachers as well as on student achievement. Shidler highlighted the importance of four components to effective coaching and training that are remarkably parallel to this study: (1) focused professional development topics, (2) modeling practices, (3) observing teacher practices, and (4) ensuing consultation for joint reflection.

Similarly, Teemant, Wink and Tyra [18] studied teachers who participated in professional development enhanced with instructional coaching. They discovered that this combination led to significant positive changes in how teachers organized their classrooms to facilitate student interaction and teachers' level of student-centered pedagogy. The value of observation and debriefing with another teaching professional has been shown as an effective means to support training, especially when new and/or uncomfortable practices are being attempted [19]. This is particularly the case when coaching is implemented in the context of *sociocultural* professional development. Sociocultural implies instructors learning together (i.e., a learning community) and integrating a coach into the professional development furthers the community and establishes a chain of assistance [20]. Kretlow and Bartholomew [21] examined the effects of this type of connected coaching in a meta-analysis of studies related to instructional coaching and found "that highly engaged, small-group initial training, followed by multiple observations, feedback, and modeling are critical components" that support effective integration of student-centered learning.

Within higher education, there exist anecdotes of some institutions providing instructional coaching service for professors; however, the dynamic has not been studied and reported well in peer-reviewed research. More often, as Caffarella and Zinn [22] reported, no coaching is the norm. The studies that do focus on coaching in higher education primarily focus on the effects of peer coaching [23]. Peer coaching can take on multiple forms and may or may not involve classroom observations and associated feedback. Typically, peer coaching is defined broadly as two faculty members working together "to improve or expand their approaches to teaching" [23]. Teaching in higher education is typically only observed by students, which may not provide insight for improvement, or occasionally by administrators, which can be stressful [24]. However, when observations are conducted by academic experts, faculty are more receptive to engaging in discussion about teaching and are most likely to be amenable to change [24].

Methods

The sample of 26 faculty members (21 coached, 5 not coached) was first examined to consider the degree to which course types shifted from fall to spring. All five non-coached faculty members taught a classroom-based (i.e., lecture or recitation) course both semesters. Among the 21 coached faculty members, 16 were observed teaching classroom-based courses both semesters; three were observed teaching lab-based courses both semesters; and two were observed teaching lab-based classes in the fall and classroom-based classes in the spring. Because a strong case was made throughout the workshops that student-centered learning could be integrated into all types of classroom environments, data from the two faculty members who were observed teaching in the different class environments (i.e., lab and then lecture-hall) were retained. However, we were mindful to later examine those data separately to help develop future questions.

To evaluate whether change in RTOP scores from pre- to post-observations was statistically significant, a paired samples t-test was used to assess differences. The pre-observation RTOP mean was compared to the post-observation mean (n = 26).

The RTOP's 25 items address five constructs of student-centered learning with five RTOP items supporting each construct. Changes in mean scores across these subsets were also examined, from Fall 2016 to Spring 2017, to determine if changes were concentrated in any particular areas. The five constructs of the RTOP are provided in Table 1, each with a representative item.

Table 1. RTOP constructs with representative items

RTOP Construct	**Representative Item**
Lesson Design (items 1-5)	The lesson was designed to engage students as members of a learning community.
Propositional Knowledge (items 6-10)	The lesson promoted strongly coherent conceptual understanding.
Procedural Knowledge (items 11-15)	Students made predictions, estimations and/or hypotheses and devised means for testing them.
Communicative Interactions (items 16-20)	There was a high proportion of student talk and a significant amount of it occurred between and among students.
Student/Teacher Relationships (items 21-25)	Students were encouraged to generate conjectures, alternative solution strategies, and/or different ways of interpreting evidence.

Two approaches were applied to evaluate the effect of coaching. First, an independent samples t-test was computed to compare the change in RTOP scores between the 21 faculty members who received coaching and the five faculty members who participated in the professional development but did not receive coaching. Second, normalized gain scores (aka Hake scores) were calculated to provide comparisons independent of pre-RTOP scores. The normalized gain scores are the proportion of change in RTOP scores compared to possible change.

Results

Regarding the overall effect of participating in the professional development program, analysis indicated a positive effect. RTOP mean scores increased significantly ($n = 26$, $p = .014$) from pre-observations ($\bar{x} = 57.07$) to post-observations ($\bar{x} = 68.63$).

Scrutiny of the five RTOP constructs revealed that changes were positive and dispersed across all constructs. Total and subsection construct results are provided in Table 2.

Table 2. RTOP change from pre- to post- (Fall 2016 to Spring 2017).

	Mean (Std Dev)			
	pre	post	Δ	*p*
Lesson Design	10.17 (4.06)	11.94 (3.31)	1.77	.050
Propositional Knowledge	16.42 (1.82)	17.93 (1.20)	1.51	.001
Procedural Knowledge	9.54 (3.25)	11.77 (3.00)	2.22	.007
Communicative Interactions	10.10 (3.67)	12.71 (3.01)	2.61	.002
Student/Teacher Relationships	12.33 (4.01)	15.29 (3.03)	2.96	.001
Total	57.07 (15.22)	68.63 (12.34)	11.56	< .001

The comparison of the small group of five faculty members, who opted to not receive coaching, to the 21 faculty members, who opted for coaching, did not allow for robust comparison. However, although not statistically significant, the coached group had notably greater mean RTOP gains from pre-to-post (Δ = 12.8, SD = 12.8) than the non-coached group (Δ = 6.2, SD = 8.8).

Similarly, calculation of normalized gain scores, although not statistically significant, indicated benefits of being coached. The coached group had conspicuously greater normalized gain scores (g = 0.20) than the non-coached group (g = 0.13).

Discussion

Limitations of this study were the small sample sizes and the self-selection aspect. The observed practices from multiple observations of 26 faculty members is robust enough to support conjecture that the professional development, coupled with subsequent community of practice participation, promotes movement toward student-centered instruction. However, this needs to be processed with the understanding that although the participants received a nominal stipend for participation, their participation in the professional development and communities of practice was voluntary. Additionally, the comparison of coached (n = 21) and non-coached (n = 5) faculty members is comprised of small and unbalanced sample sizes. Therefore, although positive effects of coaching were observed, this is considered an early exploration.

With these limitations in mind, two major implications are garnered from this study. First is the indication that participation in targeted professional development and learning communities can affect teaching practices. This is aligned to findings from prior research [6]. The use of an economical observation protocol to measure actual practices versus relying on self-reported data augments the validity of the study as well as the approach of this IUSE project. We have previously reported from this same project about the improvement of participating engineering faculty member's beliefs as measured by the Approaches to Teaching Inventory (ATI) [4]. The ATI data indicated significant shifts in attitudes towards student-centered practices through pre- and post-ATI score comparison. This study confirms an alignment of shifting practices and beliefs. However, whether a change in beliefs commonly precedes a change in practices or vice versa remains uncertain.

The second implication relates to instructional coaching. The practice of an instructional specialist observing teaching and then providing feedback is common in K-12 but rare in higher education. The proposal to provide direct feedback to instructors along with suggestions for improvement emerged from the faculty. At first, the project team discussed that providing this additional support was not part of the designed project and it might muddy the waters of evaluation. However, it was soon resolved that this was simply part of the emergent and natural process of instructors wanting to improve their own teaching. Coaching was offered to all participants and the majority opted for this even though it meant an additional time commitment beyond the regular professional development. Therefore, we have evidence that there is a desire for such service. Contrary to mythos of isolated engineering faculty who merely want to lecture, there definitely appears to be a community of engineering faculty who are not just willing but anxious to be observed and receive feedback from an instructional coach.

As we continue to evaluate the effects of the workshops, communities of practice, and the coaching, evidence will become more robust. As noted, small sample sizes were a limitation. However, as the project continues more faculty participants snowball into new cohorts. At forthcoming ASEE conferences and through other presentations and publications we will report on the effects of the project's elements with considerably larger n-sizes. What we have reported here are indications of the overall value of the project on teaching practices and a noteworthy interest and effect of coaching.

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