# A Multidisciplinary Professional Development Program that Shifts Faculty Attitudes and Practice Toward Evidence-Based Instructional Strategies (EBIS) for Teaching and Learning

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## Abstract

More effective teaching and learning can be promoted through faculty professional development that shifts delivery from instructor-centered, information-transmission teaching by lecture to more student-centered, conceptual-change learning by active learning through student engagement. The National Science Foundation IUSE (Improving Undergraduate STEM Education) project has funded a large-scale faculty development program at a large southwestern university called Just-in-Time-Teaching with Two Way Formative Feedback for Multiple Disciplines (JTFD). The first full year of the project has trained 43 faculty in four of seven disciplines using a train-the-trainer model to engage faculty in year-long apprenticeships on evidence-based instructional strategies (EBIS) for teaching and learning. The first semester of professional development was comprised of 8 biweekly workshops followed by a second semester of 6 disciplinary community of practice (CoP) discussion sessions that supported classroom innovation implementation. These sessions supported participants' implementation of innovation in their classrooms and discussed issues, opportunities and challenges that faculty encountered as they developed and tested strategies for shifting their classrooms toward greater EBIS practices.

Faculty change related to EBIS and its use was assessed with pre and post surveys with respect to faculty awareness, use, motivation, and practice. For awareness of familiarity of EBIS on topics like effective learning, active learning, and student teams there was a 31% average positive change. For EBIS use on four items of active learning, cooperative learning, objectives and Blooms' taxonomy there was a 26% increase. To determine motivation to implement EBIS strategies of real-world applications, student-to-student discussions, and formative feedback, a new survey using expectancy-value theory was created called Value, Expectancy, and Cost of Testing Educational Reforms Survey (VECTERS). There were positive gains for all three strategies for motivation (expectancy, value, and lowered cost) and reported and planned use, with the highest gains for real-world applications of 8% to 12%. Teaching with more EBIS student-centered classroom practice was assessed with classroom observations with a tool called Reformed Teaching Observation Protocol (RTOP) which has 25 items related to EBIS practice and is used by trained observers to assess classroom practice. There was a positive gain of 22% for all faculty from pre (early fall) to post (late spring) observations indicating a significant shift toward EBIS classroom practice. For the CoP sessions there was a short post-session quantitative and qualitative survey given for all six sessions. All results were quite positive across the six meetings with Likert scale responses of 4.5 to 4.6 on a 5 point scale on topics such as session relevance to teaching, new ideas for implementation, value of community building, and that collaborative and cooperative strategies can improve instruction effectiveness. Overall, results of the first year of the project have had a very positive impact on participating faculty and demonstrate that the JTFD approach is successful and could be a model transportable to other disciplines and institutions.

## Introduction

Research has shown that instruction through active learning by student engagement is more effective than traditional knowledge transmission through lecture [1], [2]. However, most engineering faculty still teach as they were taught, by information transmission through lecture. Thus, the challenge becomes as to how to shift instruction and classroom practice from faculty-centered teaching to student-centered learning. Creating materials that can be used for engagement teaching is insufficient because there needs to be an actual shift in faculty beliefs about their own instruction. Such a shift needs to move instructors from viewing themselves as disseminators of knowledge and concepts to learning advocates who facilitate students in learning the desired knowledge and concepts through their own engagement with fellow students. A means to promote this shift in beliefs and practice has been the creation of a faculty development program. Such a program is funded by the National Science Foundation IUSE (Improving Undergraduate STEM Education) program for large-scale faculty development program at a large southwestern university. It is called Just-in-Time-Teaching with Two Way Formative Feedback for Multiple Disciplinary (JTFD) Programs. The project scales a previous, smaller single disciplinary development program, Just-in-Time Teaching with Frequent Formative Feedback (JTF) [3], to seven engineering disciplines with 83 faculty. The seven disciplines include aerospace (AE), biomedical (BME), chemical (CHE), civil, (CEE) materials (MSE), and mechanical engineering (ME), as well as construction (CON). It uses a train-the-trainer model to engage faculty in year-long apprenticeships with a first fall semester of eight biweekly workshops followed by a second spring semester of six biweekly mentor-supported, disciplinary community-of-practice (CoP) classroom implementation biweekly discussions.

In the earlier JTF collaborative project seven materials science faculty participated in the program over a four-year period. The guiding principles of the project were based on the research findings described in the book, How People Learn (HPL) [4]. The book described how cognitive processes that instructors needed to foster to achieve learning through conceptual change. These processes included: 1) eliciting students' prior knowledge to inform instruction; 2) engaging students to promote conceptual change so they are able construct deep knowledge organized in a conceptual framework; and 3) encouraging students' metacognition so they can build habits of expert learners who define their learning goals and monitor their own progress. These principles were realized through student reflection, student engagement, and contextualization of concepts by linking abstract concepts to real-world concrete examples. Faculty beliefs were changed as revealed by a survey that found eight out of eight faculty said, in the last two years of using JTF pedagogy, their classroom practice had "changed somewhat or changed significantly." Another survey question showed that 7 of 8 felt that their views about teaching had changed "somewhat or significantly." On an open-ended survey faculty were queried, "How do you view your role in the classroom now as compared to before joining *JTF*?" A typical response was, "More as a coach and encourage and guide the students to do the necessary mental gymnastics to improve their comprehension and mastery of the topics."

The impact on students' attitude, persistence and achievement was also very positive. One quote from a student reflection was, "Muddiest Point items are a powerful tool that shows a teacher where students are not understanding all information." Results for student persistence from second week of class to the final showed that, across four collaborating institutions, persistence was 95% to 97% for 938 students over 9 classes introductory materials engineering classes. The impact on grades was also quite positive. Comparing grade distributions for four instructors after three years

of using JTF pedagogy resulted in a positive grade shift of a half to a full grade point average. Also, D's and E's were reduced by more than 50%. During the four years of the program the participants met on a monthly basis in a virtual community of practice (CoP) via Adobe Connect during the academic year. They also participated in three retreats over the same time period. Thus, a successful CoP had developed that was centered on teaching of introductory materials science courses. The combined effect of learning fundamental principles and practice engagement pedagogy, of implementing the JTF pedagogy, and development of a CoP resulted in shifting of faculty beliefs and classroom practice from instructor-centered teaching toward student-centered learning, which is the basis for implementing evidence-based instructional strategies (EBIS) into the classroom [5]. This resulted in positive outcomes of student attitude, achievement and persistence. Scaling this approach was used in developing the JTFD project.

As previously stated, JTFD scaled the JTF project to seven engineering disciplines with 83 faculty using a train-the-trainer model. As such, the JTFD project objectives included: shift faculty beliefs, strategies, and practice toward student-centered learning; assess faculty fidelity of implementation of engagement, reflection, and feedback pedagogy; develop sustainable disciplinary communities of practice through the faculty development program; and assess the effect on student achievement and persistence. The background and data on the project's first year cohort of faculty will now be discussed.

## Background

### Structure of the Faculty Development Program

The program is similar to the Pimmel et al. [6] "train-the-trainer" model. For this model the project investigator team trains disciplinary leader pairs (DLPs) from various disciplines in one academic year. Then the following year each DLP trains their own disciplinary faculty cohorts based on their own training. Here, *JTFD* project faculty provided a two-semester program first for a Cohort 1 (AE, ME, CE, and CON) and then the next year for Cohort 2 (BIO, CHE, and MSE) Tier 1 Disciplinary Leader Pairs (DLPs). After that, during the next academic year, the Tier 1 DLP trained their own Tier 2 Disciplinary Faculty Groups (DFGs) composed of 8-12 faculty each. Thus, in Year 1, Cohort 1, Tier 1 DLPs, (AE, ME, CE, and CON) were trained and assessed by project faculty in an 8-week biweekly spring semester program on evidence-based instructional strategy and JTFD pedagogy. Because of the limited time of the spring semester only for this first cohort of DLPs during spring 2016, they also implemented innovations in their classrooms during that same semester with support of project faculty. In project Year 2 the Cohort 1 (AE, ME, CE, and CON), Tier 1 DLPs then trained their own Tier 2 disciplinary faculty groups, by replicating their own training when they oversaw workshops during fall 2016 semester and classroom implementation discussion sessions during spring 2017 semester. Thus, the Tier 1 DLPs developed their own disciplinary CoPs with their Tier 2 DFGs and provided support during training and implementation.

Also in Year 2, project faculty trained the Cohort 2 set of Tier 1 DLPs (BIO, CHE, and MSE) in the same way used for Cohort 1 DLPs. That means workshops in the fall 2016 semester and implementation discussion sessions in the spring 2017 semester. Then, the following academic year, those Cohort 2 (BIO, CHE, and MSE), Tier 1 DLPs are each training their own Tier 2 DFGs, by

replicating their own training with workshops during fall 2017 semester and classroom implementation discussion sessions during spring 2018 semester. The overall details and schedule for the Tier 1 and Tier 2 "train-the-trainer" model are shown in Table 1.

**Table 1. Training Schedule for Disciplinary Leader Pairs and Disciplinary Faculty Groups**

| | Cohort 1 Tier 1 *Disciplinary Leader Pairs (DLPs)* AE, CHE, ME, MSE | Cohort 1 Tier 2 *Disciplinary Faculty Groups (DFGs)* AE, CHE, ME, MSE | Cohort 2 Tier 1 *Disciplinary Leader Pairs (DLPs)* BME, CE, CON | Cohort 2 Tier 2 *Disciplinary Faculty Groups (DFGs)* BME, CE, CON |
|---|---|---|---|---|
| Year 1 F15 - Sp16 | Being Trained by *Project Leaders* + Classroom Implementation | | | |
| Year 2 F16 – Sp17 | Follow-on Assessment of DLP Faculty Individuals' Classroom Practice | Being Trained by *Discipl. Leader Pairs* + Classroom Implementation | Being Trained by *Project Leaders* + Classroom Implementation | |
| Year 3 F17 – Sp18 | | Follow-on Assessment of DFG Faculty Individuals' Classroom Practice | Follow-on Assessment of DLP Faculty Individuals' Classroom Practice | Being Trained by *Discipl.. Leader Pairs*+ Classroom Implementation |
| Year 4 F18 – Sp19 | | | | Follow-on Assessment of DFG Faculty Individuals' Classroom Practice |

The topics for the first fall semester 8-week biweekly workshop training are based on EBIS and JTFD pedagogy with sessions that link research to practice and include the following:

1. Introduction to Active Learning and Disciplinary Communities of Practice
2. Bloom's Taxonomy and Writing Effective Learning Objectives
3. Pedagogies of Engagement I: Making Class Sessions More Interactive
4. Pedagogies of Engagement II: Implementing Active Learning in the Classroom
5. Pedagogies of Engagement III: Cooperative Learning – Structured Teams
6. Motivation and Learning
7. Promoting Inclusive Practices in the Classroom
8. Muddiest Points and Other Tech Tools; Facilitating Course Innovation

During the second semester in the spring the implementation of innovation discussion sessions occurred in the disciplinary communities of practice (CoP) [7], [8]. The faculty from Cohort 1 were polled to determine the topics of foremost interest and then six biweekly discussion sessions were structured to include the most requested topics. These included the following topics, issues, and concerns.

1. Opportunities and Issues in Implementation of Bloom's Taxonomy and Active Learning
2. Assessing Student-Centered Learning vs. Instructor-Centered Teaching
3. Implementation of Tech Tools and Impact of Summative and Formative Assessment
4. Discussion of Observations of Active Learning Classrooms of Project Leaders
5. Implementation of Cooperative Learning and Motivation
6. Implement Wrap-up of Faculty Beliefs, Instructor Role in Classroom, & Value of CoPs

## Structure and Content of Workshops and implementation Discussion Sessions

Each academic year's program consists of a fall semester of workshops followed by a spring semester of supported implementation discussions within each disciplinary community of practice. The topics for the first semester 8-week workshop training are based on evidence-based instructional strategies and JTFD pedagogy with sessions that link research to practice. First, the subject for each week was determined, and a time management schedule was created. Then readings, web sites, and videos were selected for each workshop. The project members developed PowerPoint presentations, which went through a thorough review process. Throughout the planning process, project members were purposeful in selecting readings and developing presentations that would engage faculty to promote student-centered learning strategies. As previously discussed, the workshop topics were previously described.

The training sessions were intended to model effective classroom practice. Each workshop consisted of an introduction, brief discussion of homework results, a short mini-lecture on the main topic, a breakout with discussion of concepts along with a few relevant open-ended questions, then followed by a report out from each group (usually two or three) to all participants. A short wrap up completed the workshop. Report outs were recorded on white boards to facilitate communication and to present comments and highlights. Initially the workshops were planned for 90 minutes, but during the first session about half of the faculty present had to leave due to class obligations, so session durations were reduced to 60 minutes. This generally worked fine, but stricter time management was required, which sometimes limited discussions to shorter, more focused contributions. Preparation (or homework) for each workshop consisted of one or two short readings from the research literature and plus a reference to one or two web sites and/or videos. Participants also had a short homework which was to be completed the day before the workshop for brief discussion at the start of the next workshop.

## Structure of Supported Implementation Community of Practice Discussion Sessions

The second semester in in the spring in each academic year program consisted of six biweekly supported implementation discussions within each disciplinary community of practice. The topics were based on input from faculty combined with some short refresher material from earlier workshops in and a few key critical open-ended questions related to implementation of innovations in classroom practice. Those topics were previously described.

Each CoP discussion session has a short handout and PowerPoint with refresher materials from the first semester workshops along with some key open-ended questions related to participants' viewpoints and reports on implementing innovations in their classrooms.

## Results and Discussion

Results are reported for the first Cohort 1 of 35 faculty from four disciplinary programs (AE, ME, CE, and CON). With the eight faculty from the four disciplinary leader pairs there was a total of 43 faculty involved overall. Previous results reported from the training of the DLPs the previous academic year were reported at the previous ASEE conference. Attendance for the fall semester workshops was 80% and for the spring semester implementation discussion sessions was 75%. Three pre-post surveys were created to measure changes in: faculty knowledge of EBIS research areas; classroom use of EBIS strategies; and use of faculty motivation to use key EBIS strategies. A classroom observation tool was used to measure the impact of the workshops and discussion

sessions on changes in their classroom teaching strategies through a classroom observation protocol. Finally, to examine the impact of the community of practice discussion sessions, short, one minute surveys were given to faculty at the end of each discussion session. The results from the surveys and observations will now be discussed.

The first set of data is from the Education Research Awareness and Use (ERAU) Survey in Table 2 that shows the change from pre to post extending from the beginning of the fall semester to the end of the spring semester. The four point Likert scale awareness responses were: very unfamiliar, a little unfamiliar, a little familiar, and very familiar. The four items in the Likert scale for use were: never, rarely, sometimes and frequently. The data show % in the top two categories of Likert responses.

**Table 2. Education Research Awareness and Use Data**
Change within the last two items on the scales, (*n*=26)

| Awareness Area | % of Participants in Top Two Likert-Scale Items | | Change in % |
|---|---|---|---|
| | Pre | Post | |
| Research on Effective Teaching | 63.0 | 92.3 | 29.3* |
| Research on Instructional Design | 33.3 | 69.2 | 35.9* |
| Research on How People Learn | 55.6 | 84.6 | 29.0* |
| Research on Active Learning | 55.6 | 88.5 | 32.9* |
| Research on Student Teams | 70.4 | 92.3 | 21.9* |
| Research on Student Motivation | 33.3 | 84.6 | 51.3* |
| Research on Learning Objectives | 88.9 | 96.2 | 7.3 |
| Research on Bloom's Taxonomy | 70.4 | 96.2 | 25.8* |
| Research on Professional Learning Communities | 25.9 | 69.2 | 43.3* |
| Use of Cooperative Learning | 51.9 | 88.5 | 36.6* |
| Use of Active Learning | 63.0 | 84.6 | 21.6* |
| Use of Objectives | 77.8 | 88.5 | 10.7 |
| Use of Bloom's Taxonomy | 48.1 | 84.6 | 36.5* |

*Statistically significant at the .05 level

The faculty education research awareness of the pre items ranged from 33% to 89% with values above 50% for seven of the nine items. The average of the pre items was 49% indicating that faculty had moderate familiarity with most of the topics. They were very familiar with three of the topics that had relatively high values of 70% on student teams, 89% on learning objectives and 70% on Bloom's Taxonomy. Surprisingly, the values in these areas still increased for the post items, from 70% to 92% for student teams, 89% to 96% for learning objectives, and 70% to 96% for Bloom's Taxonomy. These three areas were topics in the workshops so it was reasonable and satisfying to see that faculty unfamiliar with these topics, as well as knowledgeable faculty who increased their knowledge in these areas. These are critical areas for effective teaching with EBIS and can result in improved classroom practice. The three lowest areas and their improvements were instructional design from 33% to 69%, student motivation from 33% to 85%, and professional learning communities from 26% to 69%. The overall gain for the nine areas was 31%. The

lack of awareness or training in these areas can be an impediment to instruction since they are not topics which they have experienced in their own educational experience. However, given the tools and understanding of the fundamentals in these areas, the workshops can help faculty design more effective and efficient classroom experiences to enhance student interest and achievement. Other large gains that can positively impact teaching were: effective teaching from 63% to 92%, how people learn from 56% to 85%, and active learning from 56% to 89%. The faculty not only learned about the research, concepts and the principles in these areas, but they also built an engineering education research vocabulary and began and practiced using the vocabulary, especially in the communities of practice in the spring semester.

The use of the four strategies in the survey initially was moderate from 48% to 78%, but increased dramatically to high values of 85% to 89%. Once the faculty became aware and knowledgeable of the EBIS strategies of cooperative learning, active learning, objectives, and Bloom's Taxonomy, they then became able to start implementing them in their own classrooms. The CoP discussions also helped facilitate implementation with discussions of issues, challenges, opportunities and successes, as well as exchange of new ideas on ways to implement the strategies.

A second survey was the Classroom Practice Strategies Survey (CPSS) where the faculty listed the types of instructional strategies they used pre and post JTFD in the classroom. This survey in Figure 1 shows the changes from pre JTFD to post JTFD in the types of strategies that faculty used in their classrooms and indicates trends in changes in their classroom practice. The bars show the number of faculty who listed different strategies in their practice. The use of teacher-centered instructional methods dropped, as shown by number of faculty using lecture decreasing from 8 to 5 (-38%) and board notes from 2 to 0 (-100%). Conversely, there is a notable increase in EBIS strategies with faculty use increases in active learning from 3 to 13 (+333%) and in group work from 3 to 6 (+100%) and discussion from 2 to 3 (+50%). There are also faculty increases in EBIS strategies of real world examples from 7 to 9 (+29%) and objectives from 2 to 6 (+300%). There is also the new use of other EBIS strategies by two faculty for guided questions, videos, and notes.

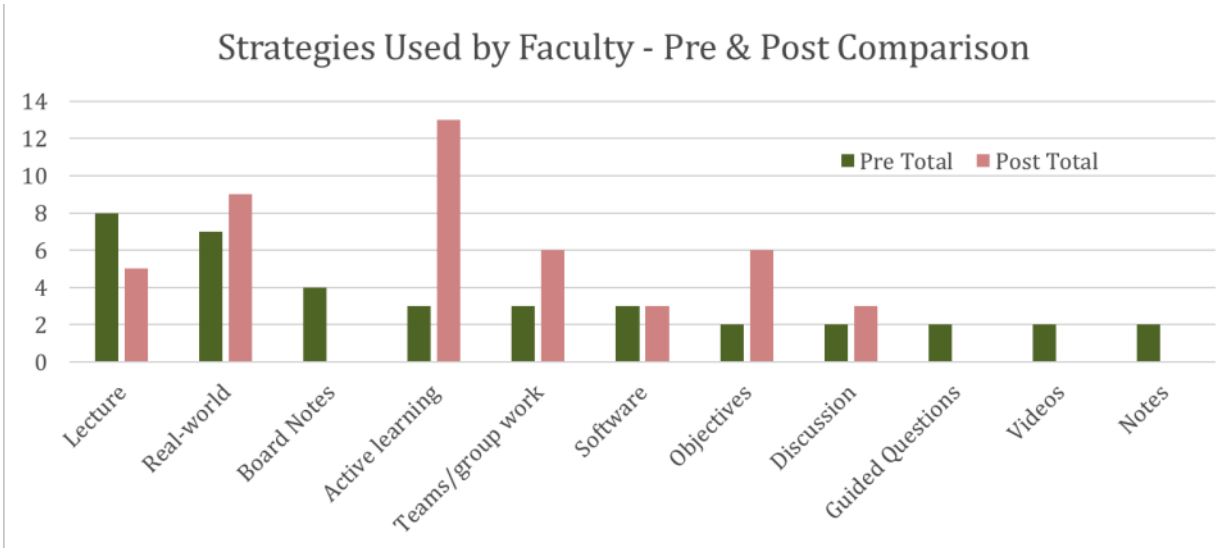


**Figure 1. Classroom Practice Strategies Survey**

These results align with those in the previous Education Awareness and Use Survey and show what strategies are actually being implemented in the classroom. Although the number of participants are limited and not statistically significant here, the trends are positive toward use of EBIS strategies, which demonstrates the positive impact of the workshops and implementation discussions sessions.

A third survey was developed and used to measure the motivation of faculty to implement three key student-centered instruction strategies of contextualization of content (or real-world examples), student to student interactions, and student reflection. The survey uses a theory to measure motivation for an endeavor of an individual to accomplish a goal and is called expectancy-value theory. This theory was applied to measure motivation for faculty to implement three key EBIS strategies and is called VECTERS (Value, Expectancy, and Cost of Testing Educational Reforms) [12]. It uses the three components of the motivation theory. They are: expectancy or expectation of success by an individual for a given strategy endeavor; value, or importance, to the individual to succeed in using a given strategy endeavor; and cost, or the sacrifices given by the individual to implement a strategy endeavor with factors such as time and effort and psychological stress. An individual is more likely to implement an instructional strategy in their classroom if there is a gain in its expectancy, a gain in the value, and a decrease in the cost to an individual. The results are shown in Table 3.

**Table 3. VECTERS Survey Results**
Percent Change from Pre- to Post-Evaluation

| | **Real-World Applications** | **Student-to-Student Discussions** | **Formative Feedback** |
|---|---|---|---|
| **Expectancy** | +8%* | +4% | +8%* |
| **Value** | +8%* | +5% | +8%* |
| **Cost** | -13%* | -7% | -7% |
| **Reported Use** | +12%* | +4% | +4% |
| **Planned Future Use** | +15%* | +4% | +2% |

*Significant at the 0.05 level

As can be seen for the motivation to implement real-world applications, there are moderate, statistically significant increases of +8% for expectancy, +8% for value and a decrease if -13% for cost. This indicates that there is a good likelihood that more faculty will implement real-world applications in their classes. This is also supported by the fact that there were increases in reported use over the time of two semesters of +12% and future use of +15%. For implementing the strategy of student-to-student discussions there were smaller, not statistically significant increases of +4% for expectancy, +5% for value and a decrease if -7% for cost. Thus, there is positive, but more limited motivation for implementing student-to-student discussions, as also shown by small increases in reported use of +4% and in future use of +4%. Thus, there is a positive, but lower level of motivation for implementing this EBIS strategy. It may be that there is a strong need for presentation of evidence from the literature of the value of student engagement on students' persistence and achievement. This is being done in the current Cohort 2 faculty development activities this

academic year. For implementing the strategy of formative feedback there were moderate, statistically significant increases of +8% for expectancy, +8% for value and a decrease if -7% for cost which was statistically not significant. Thus, there was generally positive, but more limited motivation for implementing student-to-student discussions, as also shown by smaller increases in reported use of +4% and in future use of +2%. Overall, there were gains in motivation for implementing key EBIS strategies as a result of the workshops and the implementation discussion sessions. This is reflected directly by the fact that the next section shows that classroom observations showed a significant shift in instructor practice from instructor-centered teaching to student-centered learning.

Another important tool for looking at project impact on faculty is the Reformed Teaching Observational Protocol (RTOP) [9] - [11]. The RTOP is a classroom observational protocol that quantitatively characterizes the extent to which faculty implement EBIS student-centered behaviors in their own classroom practice. It is a 25 item classroom observation tool that characterizes the extent of instructor-centered versus student-centered classroom behaviors. Data was collected with two classroom observations made at three times during the project. The first pair of observations (pre) was at the project beginning at the start of the fall. The second pair of observations was made at the beginning of the spring term (mid). The final pair of observations was made at the end of the spring term (post). The data are shown in Table 4.

**Table 4. Percent Change in Average RTOP Scores**

| Pre to Mid | Mid to Post | Pre to Post |
|---|---|---|
| 5%* | 16%* | 22%* |

*Statistically significant at the 0.05 level

The data show that there was a large overall shift of 22% toward student-centered learning from instructor–centered teaching from pre at fall semester start to post at spring semester end. The shift, though, was not linear from beginning to end, but rather had a smaller incremental change of +5% from pre to mid at the beginning of the spring term. This shift occurred over the time that the eight workshops were given during the fall. The instructors were in the process of learning and understanding the concepts and principles of EBIS instruction and probably did not have time to implement the strategies in the classes that they were teaching. However, given the four-week time span over winter break to prepare their spring classes, faculty evidently had time to plan and implement some of the EBIS strategies that they had acquired. This is demonstrated by the fact that there was a large gain between mid and post observations of 16%. This may have also been partially impacted by the implementation discussion sessions which helped faculty to gain confidence and understanding of approaches to better implement EBIS strategies. The impact on student persistence and performance of the increase in student-centered learning will be assessed through data analysis this coming summer when participating faculty pre-JTFD versus post-JTFD class grade distributions are analyzed.

The last sets of data are from short surveys given at the end of each of six Community of Practice (CoP) discussion sessions called CoP Minute Surveys (CoPMS). The first set of data shows standard Likert scale of 1 to 5 statements given at the end of each session. The scale ran from 1 = strongly disagree to 2 = disagree to 3 = neutral to 4 = agree to 5 = strongly agree. Below this data set is the same listing of the six discussion session topics that will be considered in comparison

with the data for the session shown in Table 5. Also shown is an additional data set from the final implementation discussion session which served as an overall, wrap up assessment from the faculty about their overview of the impact of the JTFD project as a whole. The statements and the data are shown in Table 6.

Session Topics included the following:

1. Opportunities and Issues in Implementation of Bloom's Taxonomy and Active Learning
2. Assessing Student-Centered Learning vs. Instructor-Centered Teaching
3. Implementation of Tech Tools and Impact of Summative and Formative Assessment
4. Discussion of Observations of Active Learning Classrooms of Project Leaders
5. Implementation of Cooperative Learning and Motivation
6. Implement Wrap-up of Faculty Beliefs, Instructor Role in Classroom, & Value of CoPs

**Table 5. Average CoP Survey Scores by Session and Total (out of 5 points)**

| Question | Session | | | | | | Total |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | |
| The topics discussed in this session were relevant and helpful to my teaching practice | 4.5 | 4.5 | 4.5 | 4.7 | 4.7 | 4.5 | **4.56** |
| The topics discussed provided me with new ideas for implementation and/or reaffirmed strategies I am currently implementing | 4.4 | 4.4 | 4.3 | 4.4 | 4.6 | 4.5 | **4.43** |
| The discussions and community-building with other faculty is valuable | 4.6 | 4.4 | 4.7 | 4.7 | 4.8 | 4.6 | **4.63** |
| Average | 4.50 | 4.43 | 4.50 | 4.60 | 4.70 | 4.53 | **4.54** |

The data shown in Table 5 across the six weeks of discussion sessions and across the three main areas of topic relevance to teaching, new implementation strategies, and value of community-building discussions is surprisingly and consistently high, ranging from 4.3 to 4.8 out of 5. It seems as if there was generally broad appeal of the topics to the faculty, which is not a surprise since the faculty were queried before the sessions as to what topic might be of most interest to them. There were small differences in values of the statement areas with the highest value from community-building discussions at 4.63, slightly above topics were relevant and helpful to my practice at 4.56 and slightly above providing new ideas or affirming current strategies at 4.43. In anecdotal discussions with different disciplinary faculty groups, all of them appreciated the opportunity both to meet and get together with other faculty, which occurred relatively infrequently during the academic year. They also liked talking about teaching strategies, issues, challenges and opportunities. There was not a great difference in scores based on the session topics which ranged from a low of 4.43 for Assessing Student-Centered Learning vs. Instructor-Centered Teaching versus a high of 4.70 for Implementation of Cooperative Learning and Motivation.

In Table 6 is shown the statements from the end of the last discussion session which served as a wrap up for the academic year long JTFD project including fall workshops and spring discussion sessions. As with the previous set of data from the six discussion sessions, the average scores are relatively high, ranging from 4.4 to 4.8. Additionally, 96% of faculty agreed or strongly agreed that "The JTFD project has been successful in creating a Community of Practice which supports innovation, implementation, and open dialogue between colleagues" and 100% of faculty agreed or strongly agreed that "The tools, strategies, and interaction I experienced throughout the JTFD project will be of value to my future instructional practice and career success." Thus, the wrap up survey demonstrates that overall impact and value to the four cohorts of disciplinary faculty participating in the JTFD project Cohort 1.

**Table 6. Other Questions from Session 6/Wrap-Up (out of 5 points)**

| Question | Average Score |
|---|---|
| I believe the motivation strategies can help to improve the effectiveness of instruction. | 4.4 |
| I would recommend participation in the JTFD program to other colleagues. | 4.6 |
| The tools, strategies, and interaction I experienced throughout the JTFD project will be of value to my future instructional practice and career success. | 4.8 |
| The JTFD project has been successful in creating a Community of Practice which supports innovation, implementation, and open dialogue between colleagues. | 4.6 |

## Summary and Conclusions

This paper has described the development and implementation of a large-scale faculty development program at a large southwestern university called Just-in-Time-Teaching with Two Way Formative Feedback for Multiple Disciplinary (JTFD) Programs. The project is scaling to seven engineering disciplines with 83 faculty using a train-the-trainer model to engage faculty in year-long apprenticeships with a fall semester of eight biweekly workshops followed by a spring semester of six biweekly mentor-supported classroom innovation implementation. The program is based upon evidence-based instructional strategies devised from the research literature and prior experience in a single disciplinary faculty development program. The project is being assessed with surveys, open-ended questions, and classroom observations.

Cohort 1 was composed of 35 disciplinary faculty that were led by four disciplinary leader pairs from the disciplines of construction, aerospace, mechanical, and civil engineering. Attendance was 80% for fall workshops and 75% for spring implementation discussion sessions. For an Educational Research Awareness and Use Survey of 9 items there was an average gain of 31% indicating that faculty significantly increased their knowledge of EBIS strategies. The average gain in use of EBIS strategies such as active learning, collaborative learning, objectives and Bloom's Taxonomy increased from pre to post by an average of 25%. So faculty were into not just learning about EBIS strategies, but they were putting them into use in their own classrooms. The VECTERS survey

was used to measure faculty motivation to implement three key EBIS strategies, real-world applications, student-to-student interactions, and formative feedback. There were pre to post increases in motivation in all categories, as well as an increase in usage and planned usage. This indicates that faculty were motivated to implement EBIS strategies and were doing so across the academic year. This was confirmed with the RTOP classroom observations of faculty behaviors that showed that there was a shift from pre to post of 22% from instructor-centered teaching to student-centered learning. This demonstrates the effectiveness of the JTFD academic year long program in shifting faculty beliefs and changing faculty classroom practices using the knowledge acquired from the workshops and the experience and support gained from the community of practice discussion sessions. Finally, the value of the CoP sessions was demonstrated with the short, minute survey questions at the end of each discussion session with values that ranged from 4.3 to 4.8 out of 5. Disciplinary interactions of faculty on a regular basis, while implementing EBIS pedagogy, helped faculty innovate and sustain new strategies in their classrooms during the spring semester with CoP discussions. Overall, the impact of the JTFD project is best summed up in the response to the wrap up summary where 100% of faculty agreed or strongly agreed with the statement that, "The tools, strategies, and interaction I experienced throughout the JTFD project will be of value to my future instructional practice and career success."

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