Assessing Faculty and Organizational Change in a Professional Development Program with Workshops and Disciplinary Communities of Practice

Prof. Stephen J. Krause, Arizona State University

Stephen Krause is professor in the Materials Science Program in the Fulton Schools of Engineering at Arizona State University. He teaches in the areas of introductory materials engineering, polymers and composites, and capstone design. His research interests include faculty development, evaluating conceptual knowledge change, misconceptions, and technologies to promote conceptual change. He has co-developed a Materials Concept Inventory and a Chemistry Concept Inventory for assessing conceptual knowledge and change for introductory materials science and chemistry classes. He is currently conducting research on a large scale NSF faculty development project. His team is studying how workshops on strategies of engagement and feedback with support from internet tools and resources affect faculty beliefs, classroom practice, and development of disciplinary communities of practice and associated student achievement. He was a coauthor for the best paper award in the Journal of Engineering Education in 2013 and this year has received the Michael Ashby Outstanding Materials Educator Award from the Materials Division of ASEE.

Dr. Keith D. Hjelmstad, Arizona State University

Keith D. Hjelmstad is Professor of Civil Engineering in the School of Sustainable Engineering and the Built Environment at Arizona State University.

Dr. Eugene Judson, Arizona State University

Eugene Judson is an Associate Professor of for the Mary Lou Fulton Teachers College at Arizona State University. He also serves as an Extension Services Consultant for the National Center for Women and Information Technology (NCWIT). His past experiences include having been a middle school science teacher, Director of Academic and Instructional Support for the Arizona Department of Education, a research scientist for the Center for Research on Education in Science, Mathematics, Engineering and Technology (CRESMET), and an evaluator for several NSF projects. His first research strand concentrates on the relationship between educational policy and STEM education. His second research strand focuses on studying STEM classroom interactions and subsequent effects on student understanding. He is a co-developer of the Reformed Teaching Observation Protocol (RTOP) and his work has been cited more than 2200 times and he has been published in multiple peer-reviewed journals such as Science Education and the Journal of Research in Science Teaching.

Prof. James A. Middleton, Arizona State University

James A. Middleton is Professor of Mechanical and Aerospace Engineering and Director of the Center for Research on Education in Science, Mathematics, Engineering, and Technology at Arizona State University. For the last three years he also held the Elmhurst Energy Chair in STEM education at the University of Birmingham in the UK. Previously, Dr. Middleton was Associate Dean for Research in the Mary Lou Fulton College of Education at Arizona State University, and Director of the Division of Curriculum and Instruction. He received his Ph.D. in Educational Psychology from the University of Wisconsin-Madison in 1992, where he also served in the National Center for Research on Mathematical Sciences Education as a postdoctoral scholar.

Prof. Robert J. Culbertson, Arizona State University

Robert J. Culbertson is an Associate Professor of Physics. Currently, he teaches introductory mechanics and electrodynamics for physics majors and a course in musical acoustics, which was specifically designed for elementary education majors. He is director of the ASU Physics Teacher Education Coalition (PhysTEC) Project, which strives to produce more and better high school physics teachers. He is also director of Master of Natural Science degree program, a graduate program designed for in-service science teachers. He works on improving persistence of students in STEM majors, especially under-prepared students and students from under-represented groups.

Dr. Casey Jane Ankeny, Northwestern University

Casey J. Ankeny, PhD is an Assistant Professor of Instruction in Biomedical Engineering at Northwestern University. Casey received her bachelor's degree in Biomedical Engineering from the University of Virginia in 2006 and her doctorate degree in Biomedical Engineering from Georgia Institute of Technology and Emory University in 2012 where she studied the role of shear stress in aortic valve disease. Currently, she is investigating cyber-based student engagement strategies in flipped and traditional biomedical engineering courses. She aspires to understand and improve student attitude, achievement, and persistence in student-centered courses.

Dr. Ying-Chih Chen, Arizona State University

Ying-Chih Chen is an assistant professor in the Division of Teacher Preparation at Mary Lou Fulton Teachers College at Arizona State University in Tempe, Arizona.

His research takes two distinct but interrelated paths focused on elementary students' learning in science and engineering as well as in-service science teachers' professional development. The first focus involves how language as a learning tool improves students' conceptual understandings, literacy, and representation competencies in science. His second research focus is on how in-service teachers develop their knowledge for teaching science and engineering in argument-based inquiry classrooms. This research is aimed at developing measures of teachers' Pedagogical Content Knowledge (PCK) for adopting the argument-based inquiry approach, as well as developing tools to capture the interactive nature of PCK.

Lydia Ross, Arizona State University

Lydia Ross is a doctoral candidate and graduate research assistant at Arizona State University. She is a third year student in the Educational Policy and Evaluation program. Her research interests focus on higher education equity and access, particularly within STEM.

Mrs. Lindy Hamilton Mayled, Arizona State University

Lindy Hamilton Mayled is a PhD candidate at Grand Canyon University. She is pursuing her PhD in Psychology of Learning, Education, and Technology. Her background in in K-12 education where she has served as a high school science teacher, Instructional and Curriculum Coach, and Assistant Principal. Her research and areas of interest are in improving STEM educational outcomes for Low-SES students through the integration of active learning and technology-enabled frequent feedback. She currently works as the Project Manager for the NSF faculty development program based on evidence-based teaching practices.

Kara L. Hjelmstad, Arizona State University

Kara Hjelmstad is a faculty associate in Mary Lou Fulton Teachers College at Arizona State University.

Assessing Faculty and Organizational Change in a Professional Development Program with Workshops and Disciplinary Communities of Practice

Abstract

To achieve more effective teaching and learning in undergraduate engineering education, professional development needs to promote change toward innovation of use of evidence-based instructional strategies (EBIS) in faculty beliefs and practice as well as change in organizational attitudes and norms. To develop an effective program, a strategy for change needs to be utilized and assessed at the individual level and the organizational level. Rogers Diffusion of Innovation (DOI) is an individual change model which consists of five steps of a progression towards any type of adoption of innovation change such as sports, business or teaching. The steps for adoption of change consist of awareness, interest, evaluation, trial, and adoption. Coburn's organizational innovation (COI) change model for organizations consists of four components necessary to support broader change in an educational organization, which include the following. Depth is deep change in faculty beliefs and practice. Sustainability of Innovation refers to flexibility of innovation in differing contexts or disciplines. Spread of Innovation refers to change in beliefs, norms, and principles of individuals across an organization. Shift of Ownership refers to shift in ownership from external facilitators to internal ownership by individuals and their organization. These change theories have been used to develop and assess a large scale NSF IUSE project at a large southwestern university called Just-in-Time-Teaching with Two Way Formative Feedback for Multiple Disciplines (JTFD). The first year of the project has trained 43 faculty in four disciplines using a train-the-trainer model with one semester of 8 biweekly workshops followed by a second semester of 6 disciplinary community of practice (CoP) discussion sessions.

Assessment of elements of the two change theories was done with pre-post measurements of participants with surveys, questions and classroom observations. For the DOI model, Awareness of evidence-based instructional strategies (EBIS) increased an average of 31% for topics such as instructional design and active learning. For DOI Interest and Evaluation a survey was created using expectancy-value theory called Value, Expectancy, and Cost of Testing Educational Reforms Survey (VECTERS). For three EBIS strategies of real-world applications, student-to-student discussions, and formative feedback there were 4% to 12% gains for motivation (expectancy, value, and lowered cost). For DOI Trial 91% of faculty agreed or strongly agreed that "the topics discussed provided me with new ideas for implementation and/or reaffirmed strategies I am currently implementing." For DOI Adoption, a classroom observation tool, RTOP, (Reformed Teaching Observational Protocol) showed a gain of 22% of classroom practice toward EBIS. For the COI model, Depth of Faculty Beliefs there was an average gain of 26% in faculty who said that they were sometimes or frequently using EBIS strategies of active learning, cooperative learning, objectives and Blooms's taxonomy. For Sustainability 96% of faculty agreed or strongly agreed that the JTFD project has been successful in creating CoPs which support innovation, implementation, and open dialogue between colleagues." For COI Spread of Innovation, 91% of faculty agreed or strongly agreed that "the topics discussed provided me with new ideas for implementation and/or reaffirmed strategies I am currently implementing." For Shift of Ownership 100% of faculty agreed or strongly agreed that "the tools, strategies, and interactions in the JTFD project would be of value to their future instructional practice and career success." Overall, assessment using the DOI and COI change models demonstrate faculty change and organizational change toward innovation through use of EBIS in teaching and learning.

Introduction

To achieve more effective teaching and learning in undergraduate engineering education professional development needs to promote change toward innovation of use of evidence-based instructional strategies (EBIS) in faculty beliefs and practice as well as change in organizational attitudes and norms [1-4]. To develop an effective program, strategies for change need to be utilized and assessed at the individual level and the organizational level. Rogers Diffusion of Innovation (DOI) is an individual change model which consist of five step of a progression towards adoption of change such as sports, business or teaching [5]. The steps necessary for adoption of change consist of awareness, interest, evaluation, trial, and adoption. Coburn's organizational innovation (COI) change model for consists of four components necessary to support broader change in an educational organization, which include the following [6]. Depth is deep change in faculty beliefs and practice. Sustainability of Innovation refers to flexibility of innovation in differing contexts or disciplines. Spread of Innovation refers to change in beliefs, norms, and principles of individuals across an organization. Shift of Ownership refers to shift in ownership from external facilitators to internal ownership by individuals and their organization.

These change theories have been used to develop and assess a large scale NSF IUSE project at a large southwestern university called Just-in-Time-Teaching with Two Way Formative Feedback for Multiple Disciplines (JTFD). The seven disciplines in the project include aerospace (AE), biomedical (BME), chemical (CHE), civil, (CEE) materials (MSE), and mechanical engineering (ME), as well as construction (CON). The first year of the project has trained 43 faculty in the four disciplines of AE, MAE, CE and CON. The project is structured with a train-the-trainer model [7] which has disciplinary leader pairs (DLPs) training over an academic year with a fall semester of 8 biweekly workshops followed by a spring semester of 6 disciplinary community of practice (CoP) discussion sessions [8-10]. The following year each pair of the DLPs then trains groups of 10 to 20 of their own disciplinary faculty participants using the the same materials and approaches by which they were trained.

The program is being assessed on the the effectiveness of the training program in shifting instruction from instructor-centered teaching to student-centered learning and in creating interactive disciplinary communities of practice (CoPs). The assessment strategy is based on the DOI individual change model for shifting faculty beliefs and the COI change model for developing the culture of interactive disciplinary CoPs. The assessment tools include surveys, questions, and classroom observations to characterize faculty change and CoP development. This paper focuses on the assessments and results especially with respect to the DOI and COI change models.

Background

Facilitating Shift of Faculty Beliefs toward Student-Centered Learning

There are various models of personal change processes in implementing innovation that have been used in different fields such as public health, agriculture, and have also been applied in engineering education. One model is *diffusion of innovation (DOI),* based on a book of the same title published by Rogers, now in its 5th edition [5]. The approach has been summarized with a framework of a

five stage model of adoption of innovation. The five stages that occur in an individual in the process of implementing innovation include:

1. Knowledge or Awareness - an individual is exposed to an innovation and its functioning
2. Persuasion or Interest – interest grows and an individual seeks additional information
3. Evaluation and Decision – individual decides to adopt or reject an innovation
4. Implementation or Trial – an innovation is tested by putting it into use
5. Confirmation or Adoption – occurs when use of an innovation is continued and sustained

Researchers have found that the model may be successful at the first two stages of *awareness* and *interest*, but sometimes fail at the *trial* stage, which they say can lead to decreasing effectiveness or discontinuing use of an innovation. However, there is also evidence that suggests that, providing support for implementing innovation in the third and fourth *decision* and *trial* stages, with personal or small group interactions, such as a CoP, can provide a more successful progression to the higher stages of diffusion of innovation [6]. Support from members of a CoP can also promote final *adoption* of an innovation into practice. Pimmel, et al. [7] used a virtual community of practice (VCP) implementation of Rogers' *DOI* model for faculty development using the internet. After training a group of faculty leader pairs they, in turn, trained disciplinary groups of 20 – 30 faculty participants. They used evidence-based instructional strategies (EBIS), methods, and examples, for a half semester where faculty participants progressed through the first and second stages of *awareness* and *interest* in Rogers' *DOI* model. To get through the the third and fourth stages of *evaluation* and *implementation* of the *DOI* model, a semester of supported classroom innovation implementation was used with discussions about classroom innovation successes and barriers and strategies to overcome them. Positive results were found for the VCP model and a similar approach is used in the JTFD project.

Facilitating Spread of Innovation in an Organization with a Community of Practice

A community of practice (CoP) has been defined by Wenger et al. [8] as a unique combination of three elements: a *domain of knowledge* given by a set of issues; a *community of people* who care about this domain; and the *shared practice* in which they are engaged in learning and improving in their domain. In a panel session in FIE in 2003, [9] *Communities of Practice in Engineering Education*, a question that was posed was, "How does a member of an organization gain the *insider knowledge* to learn how to act, talk, and think like a successful practitioner?" Brown and Duguid [10] suggest that, "Learning that is informal, social, and focused on meaningful problems helps create *insider knowledge*." Gaining *insider knowledge* is a major part of becoming a member of a CoP. In Pimmel et. al. [7] project the CoP promoted weeks of dialogue using the language of student engagement as issues and opportunities for use of new strategies and classroom practices developed and were adopted and sustained.

In the JTFD project, there are disciplinary CoPs that are overseen by previously trained faculty disciplinary pairs who had become the *insiders* who had implemented student-centered learning in their own classrooms. They have been facilitating discussions of the disciplinary faculty cohorts on their implementation successes, issues, and strategies to improve effectiveness of implementation of JTFD strategies. Participants in the first cohort have come together to create a new level of organization - a *new* community with novel ways of practicing and interacting by being pragmatic in working together to solve implementation problems in teaching, assessment,

and evaluation. This fits the four components of the COI organizational change and innovation model previously described which consists of four components necessary to support broader change in an educational organization. They include the following:

1. Depth is deep change in faculty beliefs and practice.
2. Sustainability of Innovation refers to flexibility of innovation in differing contexts or disciplines.
3. Spread of Innovation refers to change in beliefs, norms, and principles of individuals across an organization.
4. Shift of Ownership refers to shift in ownership from external facilitators to internal ownership by individuals and their organization.

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 discussion sessions 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. Readings, web sites, and videos were selected for each workshop that would engage faculty to promote student-centered learning strategies. 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. 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. 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

Structure of Supported Implementation Community of Practice Discussion Sessions

The second semester in the spring of 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. 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. The sessions 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

Project Evaluation Methodology

Evaluation of participating faculty includes both formative and summative components and aligns with project objectives. Data from engineering faculty is providing information about the extent to which classroom practice is changing. It will later also provide information about the impact on student persistence and achievement after the data become available, collected and analyzed. Determining the degree to which faculty beliefs have changed, as well as implemented in the classroom, is a measure of the extent to which innovation can potentially be sustained. There are mainly two types of data being collected. One is data that is from self reported surveys and questions to which the faculty respond, which involves, to an extent, subjective judgment through self assessment. The other is the objective assessment of faculty classroom practice by an observation protocol that assesses the extent of classroom practice toward instructor-centered teaching versus student centered teaching. If the training in the JTFD workshops and discussion sessions is effective in shifting beliefs and practice toward student-centered learning, the data from two types of methods should show similar trends. All changes of faculty from the beginning of their training in the workshops in the first semester to the end of their training at the finish of the discussion sessions at the end of the second semester is measured as changes between pre and post data collection points. The surveys and tools will now be described.

The first self-reported pre-post survey given was the Education Research Awareness and Use ERAU) Survey. This queried faculty about their familiarity of education research in nine areas such as instruction design, student motivation and student teams. It also surveyed faculty in their use of four important instructional strategies such as active learning and cooperative learning. The four Likert scale awareness responses were very unfamiliar, a little unfamiliar, a little familiar, and very familiar. The results of this survey are important because literature readings, videos, and web sites were used to provide foundational knowledge for the various topics in the workshops. The survey measured the changes in their foundational knowledge. The four items in the Likert scale for use were never, rarely, sometimes and frequently. In the second part of the ERAU survey the four items in the Likert scale of Use were: never, rarely, sometimes and frequently.

The second pre-post survey was the Classroom Practice Strategies Survey (CPSS) where the faculty listed the types of instructional strategies they used in the classroom. They listed responses such as lecture, active learning, and real world examples. This survey showed the changes over time in the types of strategies that faculty used in their classrooms and indicates trends in changes in their classroom practice.

A third survey was developed and used 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 expectancy-

value theory and is called VECTERS (Value, Expectancy, and Cost of Testing Educational Reforms) [11]. It uses the three components of the motivation theory. They are: expectancy or expectation of success for a given strategy; value or the importance to the individual to succeed in using a given strategy; and cost or the individual sacrifice given by the individual to implement a strategy with factors such as time and effort. Positive changes in these values indicate a greater likelihood of possible adoption of one or more of the three key student-centered strategies because of the higher motivation for doing so by a faculty member.

Another important tool for looking at project impact on faculty is the Reformed Teaching Observational Protocol (RTOP). 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 [12-14]. It is a 25 item classroom observation tool that characterizes the extent of instructor-centered versus student-centered classroom behaviors.

A final tool that was utilized was short qualitative and quantitative questions given at the end of each of six CoP implementation discussion sessions during the spring semester. These were aimed at assessing the usefulness of the topical discussions with respect to implementing innovations in faculty classrooms and the associated issues, challenges, opportunities and successes.

The evaluation framework in Table 1 provides a set of questions and data sources for *JTFD*. This framework is being revisited periodically by the team to ensure that the questions continue to be relevant. Data on student persistence and achievement for participating faculty classes has not yet available until recently and will be done this summer.

Table 1. Evaluation Framework

Types of Changes	Questions	Data Sources
Changes in faculty beliefs and attitudes about teaching and student learning	Are faculty embracing the principles of How People Learn in implementing EBIS & *JTFD*? Are their beliefs shifting toward student-centered learning?	Awareness of Research Methods survey and Classroom Strategies Survey. VECTERS for faculty attitude on motivation for teaching change
Changes in faculty classroom practice and resources	Are faculty using their training to modify their classroom instruction toward engagement and creating learning activities and resources?	Faculty surveys; RTOP for change in classroom practice created for students
Changes in student persistence and achievement	Is student persistence improving? Is student achievement improving as a result of *JTFD* instructional strategies?	Student persistence, class start to end (# present final / # present 3rd week); Student learning with fraction DFW and final grade distribution.
Changes in how faculty communicate and collaborate	Are disciplinary program communities of practice being developed / nurtured / sustained?	Social network analysis; faculty surveys; disciplinary CoP discussion meeting surveys.
Awareness and changes in faculty beyond *JTFD*	Are non-project faculty who have learned about this project interested in or using *JTFD* web tools & resources, materials, and strategies in their classrooms?	Project faculty surveys on discussion of *JTFD* with others; web or other tools adapted by other programs or universities

Results and Discussion

Results are reported for the first cohort of 35 participating 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. Attendance for the fall semester workshops was 80% and for the spring semester implementation discussion sessions was 75%.

The first set of data is from the Education Research Awareness and Use (ERAU) Survey in Table 2 that shows the change from pre-JTFD to post-JTFD 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 nine pre items was 49% indicating that faculty had moderate familiarity with most of the topics. For the nine post items the values increased on average by 31% to a final average of 80%. The items align well with the workshop topics which is demonstrated by the very good gain of 31% and provided a good foundation for faculty to develop strategies from development and implementation of innovation in their own classrooms. This positive change in awareness also supports the first stage of change in the DOI model of Knowledge and Awareness. Many faculty were unaware of the strategies in the items and so developed a broader foundation for implementation in their own classrooms.

The second portion of the survey on the U vse of EBIS strategies of cooperative learning, active learning, objectives, and Bloom's Taxonomy also shows significant pre-post gain average of 28% from 61% to 89%. This shows that, while there was moderate use of the EBIS strategies before

JTFD, there was broader use of these strategies later in the project. This positive change in use supports the fourth stage of change in the DOI model of Implementation or Trial. The faculty started testing the EBIS approaches in their own classrooms evidently with good success. This result of of greater use of EBIS strategies also supports the first component of the COI model of Depth of Faculty Beliefs as shown by the 89% usage of the four EBIS 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.

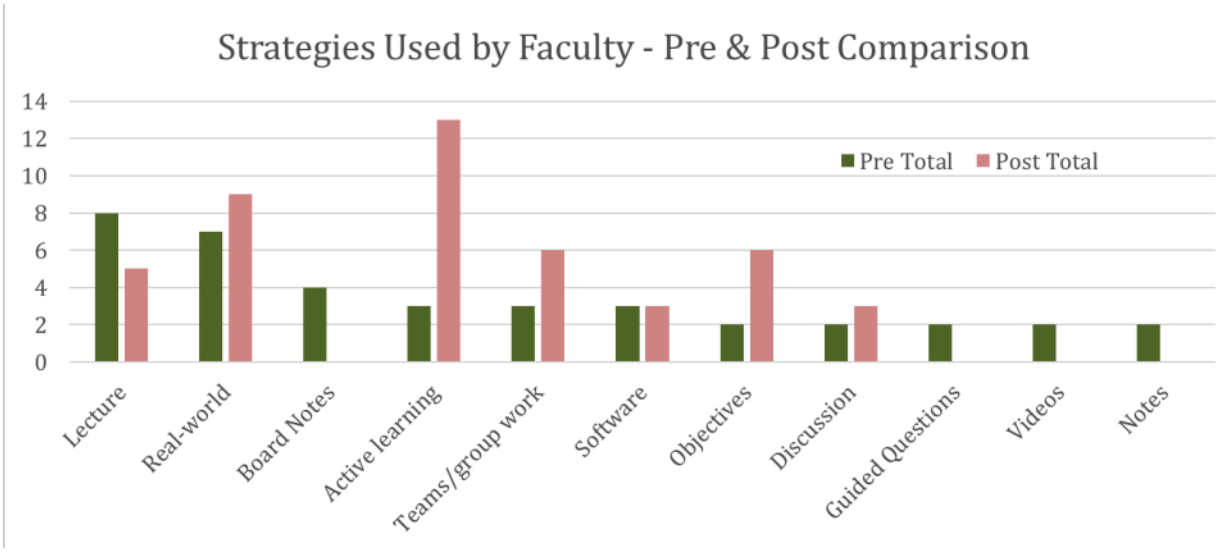

Figure 1. Classroom Practice Strategies Survey

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 results are 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. The results also are aligned with the fourth stage of change in the DOI model, Implementation or Trial, and the first component of the COI model of Depth of Faculty Beliefs, for the reasons elucidated in the discussion of the previous survey.

A third survey was developed and used to measure the motivation of faculty to implement three key student-centered instruction strategies: 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) [11]. 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%. The other two EBIS strategies student-to-student discussions and formative feedback also show positive results for increasing expectancy and value and lowering of cost, but reported use and future use are considerably lower than for real-world applications. The positive factors in motivating faculty to implement thee specific strategies, along with planned future use align well with the second stage of the DOI model of Persuasion and Interest. The faculty feel greater expectation of success and greater value at lower cost for implementing EBIS strategies in their classrooms, especially for real-word examples.

Another important tool for looking at project impact on faculty is the Reformed Teaching Observational Protocol (RTOP) [12-14]. 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 and Figure 2.

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

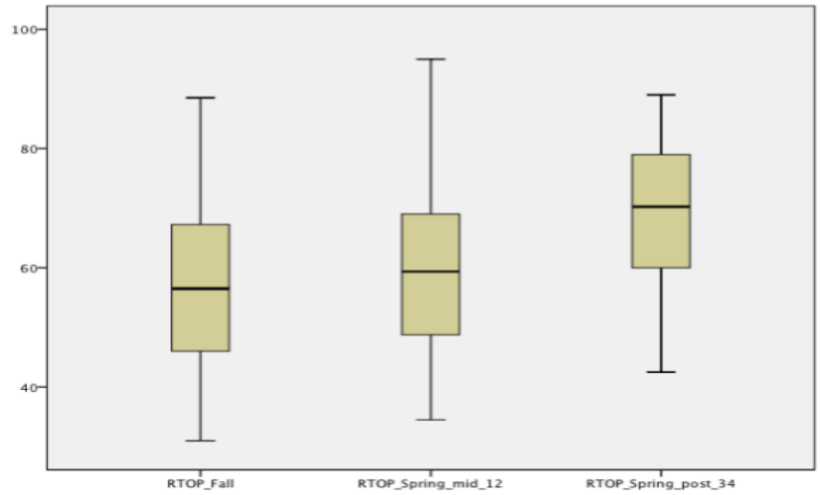

Figure 2. RTOP graph of values at pre, mid, and post points in the JTFD academic year

In RTOP observations the scale is based on 25 items which each have a value of 0 to 4, with 0 being a classroom instructor-centered behavior and 4 being a student-centered behavior. Overall scores range from 0 to 100. Classroom practice that is dominated by instructor-centered behaviors typically has overall values of 20 to 40 or lower. Classroom practice that shows mixed instructor-centered and student-centered behaviors typically shows overall scores in the 40 to 60 range. Classroom practice that is dominated by student-centered behaviors is in the range of 60 to 80 or higher. The results show that the pre-value mean of about 56 which is a mixed value skewed toward student-centered practice. This has increased moderately by 5% to 59 for the mid value after the end of the workshops, indicating a small change in practice toward student-centered behavior. There is a much larger change of 16% to 69 for the post result. This indicates that there is a significant shift into the range of student-centered classroom behaviors. The small gain of 6% from pre to mid could be representative of the third stage of the DOI model of Evaluation and Decision. Faculty during the fall semester may be testing out some of the new strategies that have learned about from the workshops and are evaluating their potential use. The larger gain from mid to post of 16% is indicative of adoption of EBIS strategies in their classrooms and represents the fifth stage of the DOI model of Confirmation or Adoption. 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 for 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. 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.

Discussion 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 1	Session 2	Session 3	Session 4	Session 5	Session 6	Total
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	**4.6**
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	**4.5**
The discussions and community-building with other faculty is valuable	4.6	4.4	4.7	4.7	4.8	4.6	**4.6**

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. There was generally broad appeal of the topics to the faculty, due to the fact that the faculty were queried before the sessions as to what topic might be of most interest to them. These are also very positive values for the DOI individual change model and the COI community change model. There were some specific interesting results of support for the models. For the fourth stage of DOI of Implementation or Trial, 91% of faculty agreed or strongly agreed that "the topics discussed provided me with new ideas for implementation and/or reaffirmed strategies I am currently implementing." This also shows similar support for the third component of the COI model of Spread of Innovation with 91% of faculty agreed or strongly agreed that "the topics discussed provided me with new ideas for implementation and/or reaffirmed strategies I am currently implementing."

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. There is specific data which here that is particularly relevant to the COI and DOI models of change. For the second component of the COI model of Sustainability of Innovation 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." For the fifth stage of DOI of Confirmation and Adoption and for the fourth component of COI of Shift of Ownership it is notable that 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 first Cohort.

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

Support of Diffusion of Innovation and Coburn's Organizational Innovation Models

Assessment of elements of the two change theories was done with pre-JTFD and post-JTFD measurements of participants with surveys, questions and class observations. For the pre-post positive changes in the five stages of the Diffusion of Innovation (DOI) model were supported by the following data:

1. Knowledge and Awareness was shown in the Education Research and Awareness and Use Survey with pre-post increases of knowledge of EBIS strategies by an average of 31% for topics such as instructional design and active learning.
2. Persuasion and Interest was shown by the faculty motivation survey, VECTERS, there were pre-post increases of intention to implement three EBIS strategies of real-world applications, student-to-student discussions, and formative feedback there increases from 4% to 12% for motivation (expectancy, value, and lowered cost).
3. Evaluation and Decision, the RTOP classroom observation showed a 6% increase in student-centered behaviors going from the pre to the mid observations. The Educational Research Awareness and Use Survey there was an 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 28%.
4. Implementation or Trial, a CoP question showed 91% of faculty agreed or strongly agreed that "the topics discussed provided me with new ideas for implementation and/or reaffirmed strategies I am currently implementing."
5. Confirmation or Adoption, the classroom observation tool, RTOP, showed a pre-post increase of 22% of classroom practice toward student-centered learning. Additionally, for a CoP wrap up question, 100% of faculty agreed or strongly agreed that "the tools,

strategies, and interactions in the JTFD project would be of value to their future instructional practice and career success."

For the pre-post positive changes in the four components of the Coburn's Organizational Innovation model were supported by the following data:

1. Depth of Faculty Beliefs, the Education Research Awareness and Use Survey showed an average gain of 26% in faculty who said that they were sometimes or frequently using EBIS strategies of active learning, cooperative learning, objectives and Blooms's taxonomy.
2. Sustainability of Innovation, a CoP question showed that 96% of faculty agreed or strongly agreed that the JTFD project has been "successful in creating CoPs which support innovation, implementation, and open dialogue between colleagues."
3. Spread of Innovation, a CoP question found that 91% of faculty agreed or strongly agreed that "the topics discussed provided me with new ideas for implementation and/or reaffirmed strategies I am currently implementing." Another CoP question found that 96% of faculty agreed or strongly agreed that "discussions and community building with other faculty is valuable."
4. Shift of Ownership, a CoP question found that 100% of faculty agreed or strongly agreed that "the tools, strategies, and interactions in the JTFD project would be of value to their future instructional practice and career success."

Summary and Conclusions

This paper has described the the assessment strategies for 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 43 faculty in four disciplines 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 project uses change theory from Diffusion of Innovation (DOI) model which describes the five stages an individual progresses through in implementing innovation. It also uses the Coburn Organizational Innovation (COI) model that describes the four components of a success process for for innovation for educational change of an organization. The DOI and COI change theories have provided a framework for the project assessment which uses tools such as surveys, open-ended questions, and classroom observations.

The first full cohort of the project 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. The data that supports the five stages of the DOI framework for individual change which are the following. For stage one DOI Interest and Awareness there was was an average gain of 31% on the Educational Research Awareness and Use (ERAU) Survey indicating that faculty significantly increased their knowledge of EBIS strategies. For stage two DOI of Persuasion and Interest the VECTERS motivation survey showed that there were gains of 4% to 12% for motivation as well as a gain of 15% for Planned Future Usage. For stage three DOI Evaluation and Decision there was on the ERAU survey an 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 28%. So faculty were into not just learning about EBIS strategies, but

they were deciding to put them into use in their own classrooms. For stage four DOI Implementation and Trial a CoP question showed 91% of faculty agreed or strongly agreed that "the topics discussed provided me with new ideas for implementation and/or reaffirmed strategies I am currently implementing." This shows that most of the faculty had decided to implement some of the new EBIS strategies in their classrooms. For stage 5 DOI Confirmation or Adoption a CoP question showed 100% of faculty agreed or strongly agreed that "the tools, strategies, and interactions in the JTFD project would be of value to their future instructional practice and career success." Additionally, the classroom observation tool, RTOP, showed a pre-post increase of 22% of classroom practice toward student-centered learning. This shows that the JTFD project was not only changing faculty beliefs, but that this change was being manifested in classroom practice.

The data that supports the four components that make up the COI framework for organizational change which are the following. For the first component of COI Depth of Faculty Beliefs, the Education Research Awareness and Use Survey showed an average gain of 26% in faculty who said that they were sometimes or frequently using EBIS strategies of active learning, cooperative learning, objectives and Blooms's taxonomy. This occurred due to the new knowledge of the faculty about EBIS strategies from the workshops and from CoP discussions about approaches to implement those strategies in their classroom practice. For the second component of COI Sustainability of Innovation a CoP question showed that 96% of faculty agreed or strongly agreed that the JTFD project has been "successful in creating CoPs which support innovation, implementation, and open dialogue between colleagues." This shows that almost all faculty felt that they had become members of a CoP with a network of colleagues who could sustainably discuss and support their efforts to innovate EBIS strategies in their classrooms. For the third component of COI Spread of Innovation, a CoP question found that 91% of faculty agreed or strongly agreed that "the topics discussed provided me with new ideas for implementation and/or reaffirmed strategies I am currently implementing." This shows that almost all faculty within the disciplinary CoPs were adopting new EBIS-based approaches to teaching in their classrooms or helped reinforce the EBIS approaches that they were already using. For the fourth component of COI Shift of Ownership a CoP question found that 100% of faculty agreed or strongly agreed that "the tools, strategies, and interactions in the JTFD project would be of value to their future instructional practice and career success." This shows that all of the faculty had taken ownership of their own versions of EBIS strategies in their classrooms and that these new EBIS-based instructional approaches would positively benefit them in their classrooms and careers. It is likely that they also feel that their students' futures will be positively impacted by these types of changes in their beliefs and classroom practice.

Overall, it has been shown that using the change models of DOI for individual change and COI for organizational change have helped create a dynamic framework that helped conceptualize and implement the creation and/or use of a series of assessment tools to effectively measure the impact of the JTFD project on faculty beliefs and classroom practice. The impact on students of these approaches will be analyzed when the faculty course data is accessed and analyzed. The data and analysis has both demonstrated the success of the JTFD approach to faculty development and also provided a set of insights about how to enhance and improve future project workshops and discussion sessions.

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