

Work in Progress: The Impact of Faculty Development Workshops on Shifting Faculty Teaching Beliefs and Classroom Practice toward Student-Centeredness

Ms. Elizabeth Lopez, Arizona State University

Elizabeth Lopez is a Master's student at Arizona State University studying biomedical engineering. She has undergone the undergraduate engineering curriculum and has facilitated the implementation of evidence-based instructional strategies in the biomedical senior design course. In JTTFD, she has evaluated and analyzed the shift in instructor fidelity towards student-centered learning.

Dr. Yong Seok Park, California State University, Fullerton

Yong Seok Park is an assistant professor in mechanical engineering at California State University Fullerton. He earned his Master's degree at George Washington University and his Doctorate at the Virginia Tech. Prior to joining California State Fullerton, Dr. Park was a postdoctoral research associate at Arizona State University. His research interests lie in undergraduate STEM education research and engineering design education.

Ms. Bethany B. Smith, Arizona State University

Bethany Smith is currently a master's student in materials science and engineering at Arizona State University. She has been involved in STEM education research since 2012 under the direction of Professor Stephen Krause. Her research interests in STEM education include faculty development, best classroom practices, and improving undergraduate engineering student retention through understanding what makes students leave engineering. She will be pursuing her PhD in Materials Science and Engineering starting in 2016 at the University of California Berkeley.

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.

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 1800 times and his publications have been published in multiple peer-reviewed journals such as Science Education and the Journal of Research in Science Teaching.

Prof. Robert J. Culbertson, Arizona State University, Department of Physics

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. 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 student and graduate research assistant at Arizona State University. She is a second year student in the Educational Policy and Evaluation program. Her research interests focus on higher education access, equity, and inclusion.

Mrs. Lindy Hamilton Mayled

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 is 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.

Prof. Stephen J. Krause, Arizona State University

Stephen Krause is professor in the Materials Science Program in the Fulton School 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 evaluating conceptual knowledge, 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 an NSF faculty development program based on evidence-based teaching practices. The overall goal is to develop disciplinary communities of practice across the college of engineering. The approach is being promoted through semester-long faculty workshops and then through a semester of supported implementation of faculty classroom innovations. Changes in faculty beliefs and classroom practice should positively impact student performance and retention. He was a coauthor for the best paper award at the FIE convention in 2009 and the best paper award in the Journal of Engineering Education in 2013.

Dr. Casey Jane Ankeny, Arizona State University

Casey J. Ankeny, PhD is lecturer in the School of Biological and Health Systems Engineering at Arizona State 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.

The Impact of Faculty Development Workshops on Shifting Faculty Teaching Beliefs and Classroom Practice toward Student Centeredness

Introduction

JTFD (Just-in-Time-Teaching with Two Way Formative Feedback (JTF) to the Multiple Disciplinary program level) is an NSF-funded Improving Undergraduate Science Education (IUSE) project at a large southwestern university. In the present study, the JTF approach has been extended to include faculty from aerospace (AE), biomedical (BME), chemical (CHE), civil (CE), construction (CON), material science (MSE), and mechanical (ME) engineering disciplines across the lifetime of the project. This novel expansion introduces and sustains evidence-based instructional strategies (EBIS) to multiple faculty through a series of workshops throughout a 9-week training period. The JTFD project aims to introduce, sustain, and assess the use of EBIS and JTFD pedagogy to faculty to promote student centered learning within multiple engineering disciplines. The implementation of such pedagogy is analyzed to determine the way two-way formative feedback is implemented to modify classroom activities and enhance student learning. Two-way formative feedback allows students the opportunity to engage in content matter by identifying areas of reinforcement and refinement to ultimately enhance individual learning. The purpose of this paper aims to sustain a shift in faculty beliefs and classroom practice towards student-centeredness whereby facilitating professional development workshops with pairs of faculty members from multiple engineering disciplines.

Methods

This project is one in which assesses participants throughout multiple university semesters for identification of trends and sustained gain for each faculty. Cohort 1 participants consisted of 3 assistant professors, 2 associate professors, 1 professor, and 2 professors of practice. The complete project timeline is displayed in Figure 1¹. During the first year of this project, Cohort 1, Tier 1

Disciplinary Leader Pairs (DLPs) were trained by JTFD project faculty during a two-semester program. The former half of this program consisted of training modules and the latter half included follow-up assessments on instructor fidelity to student centered

	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 Disciplinary 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 Disciplinary Leader Pairs + Classroom Implementation
Year 4 F18 – Sp19				Follow-on Assessment of DFG Faculty Individuals Classroom Practice.

Figure 1. Training Schedule for Disciplinary Faculty Groups and Disciplinary Leader Pairs ¹.

learning practices. This project follows the “train-the-trainer” model, in which the Cohort 1, Tier 1 DLPs conduct similar training to a second tier of Disciplinary Faculty Groups (DFGs) during the second year of the project, and so forth for subsequent semesters, as depicted in Figure 1². Cohort 1 faculty are from the aerospace, chemical, mechanical, and material science engineering disciplines. Cohort 2 introduces participates from the biomedical, civil, and construction engineering disciplines. Continuous, long term assessment of instructor fidelity to student-centered learning is conducted within each cohort DLP and DFG individually and as a group.

Each participant is required to attend workshops during the 9-week training period that teach evidence-based instructional strategies and implementation of JTF pedagogy. The topics that

encompass training within this period include the following topics: “1. How People Learn and Conceptual Change in the Classroom; 2. Using Understanding by Design Principles for Designing Effective Courses and Classes; 3. Bloom's Taxonomy and Writing Effective Learning Objectives; 4. Pedagogies of Engagement and Classroom Practice; 5. Promoting Inclusive Practices in Designing Engagement Strategies, Materials, and Practice; 6. Motivation Theory and Content Relevance and Future Value to Students; 7. Two-Way Formative Feedback and Reflective Practice by Students and Instructors; 8. Web-Enabled Tools and Resources for More Effective and Efficient Teaching and Learning; 9. Planning for Classroom Innovation in an Upcoming Course”¹. Assessment of the implementation of these principles is conducted through the Reformed-Teaching Observation Protocol (RTOP), which is an instrument “designed to constructively critique details of classroom practice,” such as cooperative learning and interactive engagement³. This instrument allows for a measure of effectiveness and faculty fidelity to student-centered teaching in the classroom. The RTOP evaluation assesses the overall lesson design and implementation of tools introduced in the training workshops. Observers are initially given a training manual and supplemental evaluations accompanied by recorded lectures in which the RTOPs were performed to learn and practice implementing the assessment instrument. Observers are trained on this 25-item evaluation tool to produce a score from 0-100, in which a traditional passive university lecture would score very low (< 20) as compared to a reformed teaching environment that implements student-centered learning strategies (>50). This evaluation tool has been used in over 400 K-20 STEM related classrooms and has been distinguished for its strong predictive validity³.

The first cohort consisted of 8 JTFD faculty that underwent a cycle of 9-week training workshops to develop and sustain JTF pedagogy and EBIS within classrooms. Two evaluators were trained in RTOP measurements and participated in the evaluations. 6 total observations were performed within these instructor's classrooms; 3 were conducted at baseline and 3 were conducted at follow up. Initial and final attitudes and beliefs towards student centered learning were recorded and assessed to attain an overall change in these metrics for each individual participant. Assessors visited the same course within the instructor's repertoire to normalize any variance in instructional strategies between course subjects. The change in RTOP scores and RTOP gain (%) were recorded for each instructor and analyzed for overall student performance. A one-way ANOVA was used to determine if the length of time that faculty participants have been teaching influences the average RTOP score and gain (%). Based on RTOP measurement and workshop participation, the participants were categorized into high and low scoring groups. The subsequent RTOP performance was measured for significance using a one-way ANOVA. Student performance was approximated by gauging student performance before and after implementation of JTFD. The grade ratio (i.e., AB/CDEW: A's and B's to C's, D's, E's and course withdrawals) was compared between two consecutive semesters to assess overall student performance. To assess the effectiveness of the JTF pedagogy, initial and follow up RTOP scores were compared for overall measure of student-centered learning.

Results

The RTOP measurements produced an initial baseline score of 36.6 out of 100, indicating much room for improvement across each of the participants. Among JTFD Disciplinary Pair leaders, overall minimum and maximum RTOP gain was calculated for a normal measure of performance, which resulted in values of 33.6 and 64.6 (%), respectively, compared to baseline. Gain was calculated by taking the difference between the maximum and minimum and dividing by the minimum score. Participant RTOP average gain is exhibited in Figure 2 and displays a similar increase across each instructor. The relationship between faculty time teaching and average RTOP score and gain was assessed with a one-way ANOVA, which did not display significant results

($p=0.5595$ and $p=0.2900$, respectively). The high and low subcategorized participant groups were compared with a one-way ANOVA, which resulted in a statistically significant difference between the RTOP scores of the groups based on workshop participation rate (%) ($p=0.0124$). To investigate the relationship between RTOP improvement and student performance, the outcome performance ratio (i.e., AB/CDEW: A's and B's to C's, D's, E's and course withdrawals) was compared before and after JTFD implementation. Within these Disciplinary Pair Leaders, three of the participants were observed before and after JTFD implementation under the same course and curriculum between consecutive semesters. Two of these participants exhibited an increase in student outcome performance ratios (i.e., AB/CDEW: A's and B's to C's, D's, E's and course withdrawals) from 0.94 and 1.00 to 1.92 and 2.20, respectively. The third JTFD participant maintained a consistent student outcome performance ratio between the two consecutive semesters.

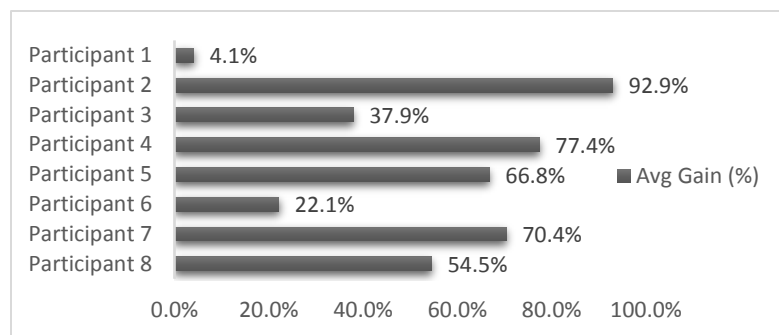


Figure 2. Individual participant maximum and average RTOP Gain (%).

Discussion/Conclusion

The goal of this paper is to display the implementation and sustainment in the shift of faculty beliefs and classroom practices towards student-centered learning across multiple engineering disciplines within a large southwestern university. Participants attended a 9-week training session that included modules to implement Just-in-Time-Teaching with Two-Way Formative Feedback (JTF) pedagogy and evidence-based instructional strategies (EBIS). The faculty fidelity to shift attitudes and beliefs towards student-centered learning were assessed with the Reformed-Teaching Observation Protocol (RTOP), in which 3 measurements were taken at both baseline and follow up. The time that participants have spent teaching did not impact the RTOP average score or gain (%) ($p=0.5595$ and $p=0.2900$, respectively), indicating that this does not limit the results reported. The faculty were divided into high and low performing groups, and the difference in gains were statistically significant, as deemed by the one-way ANOVA conducted on the data ($p=0.0124$). Student performance ratios were conducted for three participants that maintained the same course and curriculum between two consecutive semesters, before and after JTFD implementation. Increase in student performance corresponded to an increase in RTOP performance in two of the three participants. The third member maintained their student performance ratio. Evaluation of the RTOP evaluation tool displays a shift in engineering faculty attitudes and beliefs towards fidelity of EBIS and JTF pedagogy. Future work includes the dissemination of these evidence based instructional strategies and JTF pedagogy across a second cohort, as well as additional RTOP analysis for each participant. A broader impact of this novel study is increased student performance, engagement, and development throughout their engineering careers.

References

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