

BOARD # 436: Research in the Formation of Engineers (RFE): Sustaining and Scaling the Multi-Engineering Research Center Instrument Inventory (MERCII)

Dr. Jean S Larson, Arizona State University

Jean Larson, Ph.D., is the Educational Director for the NSF-funded Engineering Research Center for Bio-mediated and Bio-inspired Geotechnics (CBBG), and Associate Research Professor in both the School of Sustainable Engineering and the Built Environment and the Division of Educational Leadership and Innovation at Arizona State University. She has a Ph.D. in Educational Technology, postgraduate training in Computer Systems Engineering, and many years of experience teaching and developing curriculum in various learning environments. She has taught technology integration and teacher training to undergraduate and graduate students at Arizona State University, students at the K-12 level locally and abroad, and various workshops and modules in business and industry. Dr. Larson is experienced in the application of instructional design, delivery, evaluation, and specializes in eLearning technologies for training and development. Her research focuses on the efficient and effective transfer of knowledge and learning techniques, innovative and interdisciplinary collaboration, and strengthening the bridge between K-12 learning and higher education in terms of engineering content.

Dr. Leah Folkestad, Arizona State University

Radhika Pareek, Arizona State University

Research in the Formation of Engineers (RFE): Sustaining and Scaling the Multi-Engineering Research Center Instrument Inventory (MERCII)

Abstract

The National Science Foundation (NSF)-funded Research in the Formation of Engineers (RFE) project titled “NSF Engineering Research Centers Unite: Developing and Testing a Suite of Instruments to Enhance Overall Education Program Evaluation” aims to address the need for comprehensive evaluation tools designed specifically for NSF Engineering Research Centers (ERCs). The primary goals of the project include the creation of a Multi-ERC Instrument Inventory (MERCII), a suite of both quantitative and qualitative instruments that ERCs can use to evaluate their educational efforts. The main survey, which is modular in nature, has been converted into an operational platform/website to streamline implementation.

The MERCII Platform has gone through several iterations internally, with a concentration this past year on addressing bugs and unanticipated errors. The quantitative survey on the platform currently includes 10 sections: research center affiliation, understanding of the research center, impact on skills, culture of inclusion, mentorship experience, industry engagement, innovation and entrepreneurship, STEM-related future plans, program satisfaction, and demographic information. Pilot data from participating ERCs and other large STEM-focused centers has been used to demonstrate initial validity and trustworthiness associated with the tools, which provide a foundation for expanded use. Modifications have been made to some of the qualitative instruments, which were updated and used to evaluate programs this year. To guide newly funded centers and enhance evaluation within and across ERCs, new content has been drafted for the NSF Engineering Research Centers’ Best Practices Manual. The next steps for the project are to address the sustainability of the MERCII. Now that NSF funding is coming to an end, a permanent home for the MERCII Platform needs to be established, as is a model for ongoing technical support.

Introduction

The broader goals of this project have been to enhance program evaluation within and across NSF-funded ERCs (and other large, STEM-focused research centers) by: 1) expanding dissemination and providing validity testing of a collaborative evaluation survey, 2) developing a complementary set of qualitative tools (e.g., interview, focus group, observation protocols, etc.), 3) facilitating an evaluator’s toolbox to guide and support center evaluation leads, and 4) providing updated information to available resources (e.g., drafting new content for the NSF Engineering Research Centers’ Best Practice Manual). Over the duration of the grant, this work has been completed while aligning with each of the four NSF Division of Engineering Education and Centers (EEC) program clusters: “Broadening Participation in Engineering,” “Centers and Networks,” “Engineering Education,” and “Engineering Workforce Development.”

The ERC Evaluation Consortium (TEEC) is a team of leaders, educators, and evaluators from six different Engineering Research Centers (ERCs) that have collaborated on this project. TEEC was formed to collectively leverage expertise, experience, and resources across ERCs. This

collaborative effort has led to the design and implementation of cross-ERC events, shared programming, and streamlined program evaluation. The consortium aims to broadly impact practice within the engineer-formation system by providing a new approach to measuring the effectiveness of education and diversity programs within and across ERCs. The goal of the project is to enhance evaluation for not only individual ERCs but make it possible to expand and compare across all ERCs.

Key Outcomes and Results

The most significant achievement of the project has been the creation of the Multi-ERC Instrument Inventory (MERCII), a suite of quantitative and qualitative instruments that Engineering Research Centers (ERCs) and other large STEM-focused centers can use to evaluate their education and workforce development programming. The tools are intended to streamline the work and reduce the overhead on individual center evaluators. The results of such evaluations are designed to inform centers, help with reporting, and so that education-based activities can be continually improved. Data collected from pilot implementation of MERCII instruments has shown the tools to be reliable and trustworthy. Initial validity evidence has provided an evidence-based foundation for future use of the instruments within ERC settings [1]. In one case, the MERCII survey and interview/focus group protocols were adapted and used to evaluate three separate virtual NSF-funded Research Experiences for Teachers (RET) Programs during the same summer [2].

Finalizing the Project

The focus of the project's No Cost Extension year was to address bugs and finalize the site to ensure positive user experience. Greater use of the site would allow for an increase in data collection that could be used to further the validity and reliability evidence associated with the survey. With the current Full Stack Developer transitioning off the project, a new student worker was hired to finish the job. The team continued to meet to address bugs and functionality to refine the platform and address user needs. To assist new users of the platform, a "MERCII Quick Start Guide" job aid was created using Articulate Rise 360. A few of the Qualitative rubrics were revised to be more user friendly and streamlined. The group drafted a new chapter for the ERC Best Practices Manual focusing on evaluation and assessment and submitted it to the NSF for review. Several options for where to host and maintain the MERCII Platform long-term have been considered and will be discussed in further detail below.

MERCII Platform

Although the MERCII platform has been finalized and usable, to improve the user experience and overall functionality, there were several developmental bugs that needed to be addressed. One of the biggest challenges arose when Gmail accounts were used, instead of a school-related, ".edu" email address, to set up a user in the platform. In this scenario, only ".edu" emails were going through due to incorrect server configurations, so the necessary changes were made to ensure Gmail accounts would work as well. Permission levels tied with role access were inspected to ensure that campaign managers sending out surveys see only de-identified data. Also, roles for users who are evaluating more than one site need to have the ability to select

multiple sites. Bugs were resolved involving new accounts, site log in, adding users, email responses, and formatting. User management involved support requests, resetting passwords, deleting participants, and transferring a campaign to another user.

Beyond these issues described, the “Start” button on Active Surveys had become unresponsive, hindering proper survey launches. Deleted campaigns sometimes continued to appear on the dashboard, so the relevant SQL queries were adjusted. The “+” icon meant to add new participants within the editing campaign page was not functioning, leading to creation of a new popup interface that simplified participant addition. Additionally, adding participants to an existing campaign sometimes triggered an error message, which was addressed to ensure seamless campaign setup. Many similar bugs and fixes were made to the platform. The survey emails themselves initially had a generic subject line that could be ignored, changes were made to make them more specific and important.

Qualitative Tools

Included in the instrument inventory is a complementary set of qualitative tools, which includes a series of rubrics and protocols for instructional plans, lesson observations, poster/presentations, and observing research center group meetings. ERC education leaders, an evaluator, and an ERC director used and provided feedback on the separate versions of the REU Poster Presentation Rubrics during the summer of 2023, which was incorporated to create one simplified version of the rubric. This updated version was used to successfully evaluate several summer research experiences in 2024.

In addition to the rubrics and protocols developed for evaluating the instructional plans created during the Research Experiences for Teachers (RET) Programs, it is also important for individual centers to evaluate the technical and pedagogical aspects of the lessons before disseminating to the public. To capture technical insight and offer feedback on education activities of the Engineering Workforce Development program at one ERC, a Curriculum Committee was established, chaired by the Education Director and made up of both faculty and graduate student experts from each partner institution. To guide the pedagogical aspects of the lessons, the RET participants are given a lesson plan template to follow, along with professional development training throughout the program, delivered by the education team. Once the lessons are ready for review, they are sent to the committee, along with a template and instructions to focus on the technical aspects only. Once updates are made and lessons are finalized, they are uploaded to the center’s curriculum website.

Evaluation Chapter

A new chapter, titled “Assessment and Evaluation” has been submitted to the NSF ERC Program Officers for consideration for inclusion in the NSF Best Practices Manual. The chapter includes the following sections: overview, general guidelines, logic model, evaluation approaches and tools, data collection and analysis, evaluation feedback loops, ERC reporting, and site visits. Embedded in the draft chapter are links and notes highlighting the work undertaken by this overall project to bring visibility to resources for current and future NSF ERCs, including the MERCI survey instrument.

Sustainability

The operational MERCI Platform website (mercii.org) developed to streamline survey implementation is currently hosted on a shared server at Arizona State University. For sustainability of the project, the platform will transition to a more stable and long-term location after the conclusion of grant funding. Possibilities include an existing resource page for NSF ERCs, a group page for ERC evaluators in nanoHUB, or on the CREST website within the Knowledge Enterprise at Arizona State University.

Acknowledgement

This work is supported by the National Science Foundation Grant EEC-2023275 and partially funded by Grant 1953745. Any opinions, findings, conclusions, or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation. We would also like to thank the leadership team, education team, and the evaluation team of all partner ERCs, for their support and participation in knowledge sharing, data collection, and offering constructive feedback.

References

- [1] M. V. Melo de Lyra, A. Carberry, J. S. Larson, Z. Zhao, A. Godwin, A., W. Savenye, and C. Barr (2023). Design and Testing of a Quantitative Instrument to Evaluate Engineering Research Center Participation. Proceedings of the 2023 *American Society for Engineering Education (ASEE) Conference & Exposition*, Baltimore, MD, June 25-28, 2023. <https://peer.asee.org/42935>
- [2] J. S. Larson, M. O'Donnell, K. Eustice, C. Nichol, K. Jaskie, A. Spanias, J. Blain Christen, K. Farnsworth, M. Lee (2021). Lessons Learned from Evaluating Three Virtual Research Experiences for Teachers (RET) Programs Using Common Instruments and Protocols. Proceedings of the 2021 *American Society for Engineering Education (ASEE) Conference & Exposition*, Virtual Conference, July 26-29, 2021. <https://peer.asee.org/37438>