



Expanding Access to and Participation in MIDFIELD (Year 4)

Dr. Matthew W. Ohland, Purdue University-Main Campus, West Lafayette (College of Engineering)

Matthew W. Ohland is Associate Head and Professor of Engineering Education at Purdue University. He has degrees from Swarthmore College, Rensselaer Polytechnic Institute, and the University of Florida. His research on the longitudinal study of engineering students, team assignment, peer evaluation, and active and collaborative teaching methods has been supported by the National Science Foundation and the Sloan Foundation and his team received for the best paper published in the Journal of Engineering Education in 2008, 2011, and 2019 and from the IEEE Transactions on Education in 2011 and 2015. Dr. Ohland is an ABET Program Evaluator for ASEE. He was the 2002–2006 President of Tau Beta Pi and is a Fellow of the ASEE, IEEE, and AAAS.

Dr. Susan M Lord, University of San Diego

Susan M. Lord received a B.S. from Cornell University in Materials Science and Electrical Engineering (EE) and the M.S. and Ph.D. in EE from Stanford University. She is currently Professor and Chair of Integrated Engineering at the University of San Diego. Her research focuses on the study and promotion of diversity in engineering including student pathways and inclusive teaching. She is Co-Director of the National Effective Teaching Institute (NETI). Her research has been sponsored by the National Science Foundation (NSF). Dr. Lord is among the first to study Latinos in engineering and coauthored *The Borderlands of Education: Latinas in Engineering*. Dr. Lord is a Fellow of the IEEE and ASEE and is active in the engineering education community including serving as General Co-Chair of the Frontiers in Education Conference, President of the IEEE Education Society, and Associate Editor of the IEEE Transactions on Education (ToE) and the Journal of Engineering Education (JEE). She and her coauthors received the 2011 Wickenden Award for the best paper in JEE and the 2011 and 2015 Best Paper Awards for the IEEE ToE. In Spring 2012, Dr. Lord spent a sabbatical at Southeast University in Nanjing, China teaching and doing research. She is on the USD team implementing "Developing Changemaking Engineers", an NSF-sponsored Revolutionizing Engineering Education (RED) project. Dr. Lord is the 2018 recipient of the IEEE Undergraduate Teaching Award.

Dr. Richard A. Layton P.E., Rose-Hulman Institute of Technology

Richard Layton is a Professor of Mechanical Engineering at Rose-Hulman Institute of Technology. He received a B.S. from California State University, Northridge, and an M.S. and Ph.D. from the University of Washington. His areas of scholarship include student teaming, longitudinal studies of engineering undergraduates, and data visualization. He is a founding developer of the CATME system, a free, web-based system that helps faculty assign students to teams and conduct self- and peer-evaluations. He is a co-author of the *Engineering Communication Manual*, an undergraduate text published in 2016 by Oxford Univ. Press. He can occasionally be found playing guitar at a local open mic.

Dr. Marisa K. Orr, Clemson University

Marisa K. Orr is an Assistant Professor in Engineering and Science Education with a joint appointment in the Department of Mechanical Engineering at Clemson University. Her research interests include student persistence and pathways in engineering, gender equity, diversity, and academic policy. Dr. Orr is a recipient of the NSF CAREER Award for her research entitled, "Empowering Students to be Adaptive Decision-Makers."

Dr. Catherine E. Brawner, Research Triangle Educational Consultants

Catherine E. Brawner is President of Research Triangle Educational Consultants. She received her Ph.D. in Educational Research and Policy Analysis from NC State University in 1996. She also has an MBA from Indiana University (Bloomington) and a bachelor's degree from Duke University. She specializes in evaluation and research in engineering education, computer science education, and technology education. Dr.



Brawner is a founding member and former treasurer of Research Triangle Park Evaluators, an American Evaluation Association affiliate organization and is a member of the American Educational Research Association and American Evaluation Association, in addition to ASEE. Dr. Brawner is also an Extension Services Consultant for the National Center for Women in Information Technology (NCWIT) and, in that role, advises computer science and engineering departments on diversifying their undergraduate student population. She remains an active researcher, including studying academic policies, gender and ethnicity issues, transfers, and matriculation models with MIDFIELD as well as student veterans in engineering. Her evaluation work includes evaluating teamwork models, broadening participation initiatives, and S-STEM and LSAMP programs.

Mr. Russell Andrew Long,

Russell Long, M.Ed. was the Director of Project Assessment at the Purdue University School of Engineering Education (retired) and is Managing Director of The Multiple-Institution Database for Investigating Engineering Longitudinal Development (MIDFIELD). He has extensive experience in performance funding, large data set analysis, program review, assessment and student services in higher education. One of his greatest strengths lies in analyzing data related to student learning outcomes and, therefore, to improving institutional effectiveness. His work with MIDFIELD includes research on obstacles students face that interfere with degree completion and, as well, how institutional policies affect degree programs. His group's work on transfer students, grade inflation, and issues faced across gender and ethnicity have caused institutions to change policies so that they may improve. Awards and publications may be found at <https://engineering.purdue.edu/people/russell.a.long.1>.

Mr. Hossein Ebrahiminejad, Purdue University at West Lafayette

Hossein Ebrahiminejad is a Ph.D. student in Engineering Education at Purdue University. He completed his M.S. in Biomedical Engineering at New Jersey Institute of Technology (NJIT), and his B.S. in Mechanical Engineering in Iran. His research interests include student pathways, educational policy, and quantitative research methods.

Mr. Hassan Ali Al Yagoub, Purdue University at West Lafayette

Hassan Al Yagoub is a Ph.D. student in Engineering Education at Purdue University. His research interests include diversity & inclusion, students' persistence, advising and mentoring, engineering career pathways, and school-to-work transition of new engineers. He holds a B.S. in Mechanical Engineering from University of Wisconsin-Milwaukee and a M.S. in Mechanical Engineering from Georgia Institute of Technology. Prior to beginning his doctoral studies, Hassan worked for five years at General Electric where he graduated from their Edison Engineering Development Program (EEDP) and then worked as a gas turbine fleet management engineer. In addition to his technical role, Hassan supported the recruiting, interview, and selection process of the EEDP Program, where he mentored interns, co-ops and Edison associates from the Middle East and Africa regions by developing and teaching a technical training curriculum, providing guidance for graduate school applications, and providing career consultation.

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Executive Summary

This National Science Foundation (NSF)-sponsored project seeks to expand the number of institutions participating in the Multiple-Institution Database for Investigating Longitudinal Development (MIDFIELD) and expand the number of researchers using the dataset for research. MIDFIELD is a resource enabling the study of students that includes longitudinal, whole population data for multiple institutions. More details about the dataset are available in [1] and information about the MIDFIELD team and research conducted using MIDFIELD is available on the MIDFIELD website [2].

Expanding Participation

This project aims to expand MIDFIELD database from 11 to approximately 100 institutions containing over 10 million student records. More specifically the data will represent over 50% of the U.S. engineering undergraduate degrees awarded and increase the diversity of institutions in the dataset. MIDFIELD will include public and private institutions, minority-serving institutions, and institutions from a range of research classifications. The scope of MIDFIELD will enable significant improvements in research in higher education. It will enable the development of research capacity to examine student characteristics (race/ethnicity/sex/prior achievement/socioeconomic indicators) and curricular pathways (including coursework) by institution and over time. Because the dataset contains students records of all students matriculating over a period of time, researchers can study students across all disciplines, not just engineering. Due to the broad nature of the disciplines represented by MIDFIELD, this project has cross-Directorate support from the Directorates of Engineering, Math and Physical Sciences (MPS), and Education and Human Resources (EHR) as well as the Office of Integrative Activities (OIA). Within the MPS Directorate, this work is supported by Astronomy, and Physics; within EHR, this work is supported by the EHR Core Research (ECR) program.

Changes in Implementation

The scope of the project remains unchanged. However, we have revised our implementation strategy to help us achieve our goal of expanding institutional participation. We received NSF approval to reallocate funds from our unallocated subcontract budget – that part of our budget is to support institutions as they compile data to contribute to MIDFIELD. We have moved some of these funds to support a partnership with the American Society for Engineering Education (ASEE) that will:

- Make ASEE the archivist instead of the Interinstitutional Consortium for Political and Social Research (ICPSR). Although ICPSR is better known as an archivist, ASEE is certainly better known among engineering education researchers. When the data are available from ASEE, we (and ASEE) can publicize the availability of the dataset outside the engineering education community so that researchers in Sociology, Education, and other fields can use it for research.
- Gain the support of the ASEE Deans Council in encouraging institutional participation in MIDFIELD.
- Gain ASEE's support in publicizing MIDFIELD, which will support both of our goals.

- Enable ASEE to use MIDFIELD in publishing their DataBytes feature in *Prism* magazine and other publications.
- Establish feedback mechanisms and a community forum to support researchers using MIDFIELD (this might be through ASEE or another avenue, depending on discussions).

To achieve this, the research team will have meetings with ASEE HQ leadership, Deans Council representatives, the Deans Council Data Committee, the ASEE Board Data Committee (which is a separate entity), and ASEE's data contractor American Institutes for Research, and have discussions with current institutions about signing a new agreement. The grant will subcontract to ASEE to support staff time, legal fees to establish the data agreements, and work by American Institutes for Research to establish the data infrastructure and security protections.

We believe that this will help us achieve our goals and possibly reduce the cost of adding new institutions, since they will have a greater incentive to join the partnership.

Documentation of Institutional Policies

In addition to collecting student record information, we are continuing to compile academic policy information for each partner institution. This involves collecting and coding catalogs from each of the partner institutions during the time period of the data collected. A team of undergraduate students has been trained in human subjects' research protection and the use of NVivo software. For each partner institution and for each year they have contributed data to the MIDFIELD database, the student research team is coding the university catalogs in these areas:

- Admissions policies for engineering students – including high school GPA, standardized test scores, transfer admissions, preferential admissions (e.g., highly qualified, sociodemographic characteristics, or of a particular faith), awareness of financial need, and policies regarding admission of international students.
- Academic progress policies for engineering students - GPA and course requirements for maintaining satisfactory progress towards a degree, and required coursework for engineering; also measures of unsatisfactory progress, including warning, probation, suspension, and expulsion and performance needed to return to good academic standing.
- Engineering matriculation model – admission to a first-year engineering program, admission to an engineering major, admission to engineering for less qualified students, enrollment management (e.g., minimum GPA) in force for any engineering major.
- Financial aid - for highly qualified state residents (e.g., Georgia's HOPE scholarship), "loan free" aid policies, or for members of sociodemographic groups, standards for retaining aid.
- Grading policies – grading scale, handling of incomplete grades, course repeat, forgiveness, withdrawals.
- Disability policies, including services provided and requirements to access services.

As of February 1, 2020, policy summaries have been completed for 23 institutions and are in progress for 27 additional institutions. Summaries, the complete codebook, and the NVivo project files can be made available to researchers who wish to include institutional context with their study of MIDFIELD variables and outcomes.

Because the policy team includes several undergraduate students, we continue to present results of our research at Purdue University's undergraduate research forums in the Spring and Fall of each year, including posters exploring undergraduate academic policy trends [3], institutional standards for obtaining and maintaining financial aid [4], and a review of English as a second language policies [5].

Expanding the Network of Researchers

Another important goal of this project is educating the broader research community, expanding the network of researchers capable of conducting this research, and sharing of innovative research methods in addition to the actual data. Thus, during this past year, we held workshops at the First-Year Engineering Education (FYEE) conference [6] and the Frontiers in Education (FIE) conference [7] and held the inaugural MIDFIELD Institute in June 2019.

For these workshops and the MIDFIELD Institute, we have created the *midfielddata* practice data set—a stratified sample of data from MIDFIELD designed to facilitate accessing and analyzing MIDFIELD data. It includes student records for 97,640 undergraduate students from 1987 to 2016. We chose the R software environment because it is free, open source, available on every major platform, and provides superior tools for contemporary data graphics [8].

midfielddata is freely available to the public as an R data package on GitHub [9]. Tools for accessing and analyzing these data are provided by the *midfielldr* package, also available via GitHub [10]. Using the functions in *midfielldr*, one can select programs to study, group and summarize by race/ethnicity, sex, and program, and compute and graph various persistence metrics.

The MIDFIELD Institute brought together about twenty researchers from across the USA for two days. The goals for the workshop were for participants to be able to

- Describe the data available in MIDFIELD
- Describe how the MIDFIELD data are organized
- Describe key principles of effective data visualization
- Identify deficiencies of common graph types
- Use *midfielldr* to calculate and evaluate educational metrics, produce a table of data that addresses a research question, and explore and tell a story from MIDFIELD data

A pre-workshop session offered optional tutorials to introduce the basics of the R environment, graphing in R, and data structures in R. Day 1 began with introductions of facilitators, objectives, MIDFIELD, and participants. Then participants worked through self-paced tutorials to learn to use *midfielldr* and *midfielddata*. After lunch, we summarized some key results from MIDFIELD highlighting metaphors and metrics drawing from our *Journal of Engineering Education* paper [11]. Then we explored defining new research question with examples of specific items to consider. Day 1 ended with self-directed practice of defining a problem involving data of interest to participants. Day 2 began with a discussion of effective data visualization followed by an exploration of data with the goal of finding and presenting stories. Then participants worked on their own research question exploring data displays and creating a poster to describe their work-in-progress. The Institute ended with a poster session where

participants took turns presenting and providing feedback on all posters. More details on the MIDFIELD Institute are available at [12].

A summary of the participants' responses to specific questions evaluating the effectiveness of Institute is included in Table 1. Overall, participants rated the workshop highly with very few disagreeing on any of the items. The highest agreement was for "The activities gave me sufficient practice and feedback." and "The instructors were helpful." When asked to select ways to improve future offerings of the MIDFIELD Institute from a list, more than half of the participants selected "Provide better information before the Institute," "Increase the content in the Institute," "Allot more time for the Institute," and "Make the Institute more difficult."

Table 1: Evaluation of 2019 MIDFIELD Institute by Participants (N = 13)

	Strongly Disagree	Disagree	Agree	Strongly Agree
	1	2	3	4
The activities gave me sufficient practice and feedback.	0	0	2	11
The instructors were helpful.	0	0	2	11
This Institute lived up to my expectations.	0	0	3	10
The Institute activities stimulated my learning.	0	0	3	10
The instructors were well prepared.	0	0	3	10
The Institute was a good way for me to learn about and how to use MIDFIELD data.	0	0	3	10
The pace of this Institute was appropriate.	0	0	4	9
I accomplished the objectives of the Institute.	0	1	3	9
The Institute objectives were clear to me.	0	0	5	8
The difficulty level of this Institute was appropriate.	0	2	5	6
I was well informed about the objectives of this Institute.	0	1	7	5
The content is relevant to my job.	0	1	8	4
I will be able to use what I learned in the Institute.	0	1	10	2

Dissemination

In the last year, the MIDFIELD team has continued to disseminate results from research using MIDFIELD in various venues including conferences, invited talks at universities [13, 14, 15, 16, 17], and as panelists [18, 19]. At the 2019 American Society for Engineering Education (ASEE) Annual Conference, we presented explorations of transfer student retention [20] and GPA trajectories and their relationship to persistence in engineering [21] as well as a summary in the NSF Grantees session [22]. Two papers were presented at the FYEE conference: an expansion of the academic policy trends poster [23] and a comparison of first year course requirements across institutions [24]. Results of a study of outcomes for rural students in engineering

education were presented at the 2019 FIE Conference [25]. We have a paper accepted to appear in the *International Journal of Engineering Education* in 2020 comparing MIDFIELD and the ASEE dataset [26].

Acknowledgments

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