Expanding Access to and Participation in MIDFIELD (Year 6)

Susan M Lord (Professor & Chair)

Susan Lord is Professor and Chair of Integrated Engineering at the University of San Diego. She received a BS from Cornell University in Materials Science and Electrical Engineering (EE) and MS and PhD in EE from Stanford University. Her research focuses on the study and promotion of diversity in engineering including student pathways and inclusive teaching. She has won best paper awards from the Journal of Engineering Education and IEEE Transactions on Education. Dr. Lord is a Fellow of the IEEE and ASEE and received the 2018 IEEE Undergraduate Teaching Award. She is a coauthor of The Borderlands of Education: Latinas in Engineering. She is a co-Director of the National Effective Teaching Institute (NETI).

Matthew W. Ohland (Dale and Suzi Gallagher Professor of Engineering Education)

Matthew W. Ohland is Associate Head and the Dale and Suzi Gallagher of Professor of Engineering Education at Purdue University. He has degrees from Swarthmore College, Rensselaer Polytechnic Institute, and the University of Florida. He studies the longitudinal study of engineering students and forming and managing student teams and with collaborators has been recognized 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.

Marisa K. Orr (Associate Professor)

Marisa K. Orr is an Associate 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."

Joe Roy (Director of Institutional Research and Analytics)

Joseph Roy has over 15 years of data science and higher education expertise. He currently directs three national annual data collections at the ASEE of colleges of engineering and engineering technology that gather detailed enrollment, degrees awarded, research expenditures, faculty headcounts, faculty salary and retention data for the engineering community. He is PI of a NSF Advanced Technological Education funded grant to build a national data collection for engineering-oriented technician degree and certificate programs at 2-year institutions. Prior to joining the ASEE, he was the senior researcher at the American Association of University Professor and directed their national Faculty Salary Survey. He also developed a technical curriculum to train analysts for a national survey of languages in Ecuador while he was at the University of Illinois as a linguistic data analytics manager and member of their graduate faculty. He has a B.S. in Computer Science & Mathematics, a M.S. in Statistics from the University of Texas at San Antonio and a Ph.D. in Linguistics from the University of Ottawa.

Catherine Brawner

Catherine E. Brawner is president of Research Triangle Educational Consultants in Raleigh, NC. She received her PhD in Educational Research and Policy Analysis from North Carolina State University, her Masters of Business Administration

from Indiana University (Bloomington), and a bachelor's degree from Duke University. She specializes in research and evaluation in higher education STEM disciplines with a particular focus on underrepresented groups.

Richard A. Layton (Dr)

Richard Layton is a data visualization consultant focusing on educational research. He designs exploratory data graphics to assist a research team in discovering the stories in quantitative data and preparing visuals in which the logic of the display reflects and supports the logic of the argument. He has facilitated numerous workshops on using R for data visualization. He received his BS (1991) in Engineering from California State University, Northridge and his MS (1993) and PhD (1995) in Mechanical Engineering from the University of Washington in Seattle. Retired from teaching in 2020, he is Emeritus Professor of Mechanical Engineering at Rose-Hulman Institute of Technology.

Russell Andrew Long (Managing Director MIDFIELD & Director of Project Assessment (Retired))

Russell A. Long received the B.M. in vocal performance/music theory from Augusta University, Augusta, GA, in 1984; and the M.M. in vocal performance/music history and the M.Ed. in student personnel services from the University of South Carolina, Columbia, SC in 1989 and 1995, respectively. He is Managing Director and Data Steward of MIDFIELD at the Purdue University School of Engineering Education. He has extensive experience in large dataset construction and analysis, program review, assessment, performance-based funding, 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 faced by students that interfere with degree completion and how institutional policies affect degree programs. Mr. Long is a member of the American Society of Engineering Education (ASEE), National Institute for the Study of Transfer Students (NISTS), and Association for Institutional Research (AIR).

Hayaam Osman

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Abstract

The Multiple Institution Database for Investigating Engineering Longitudinal Development (MIDFIELD) is a valuable resource enabling the study of students that includes longitudinal, whole population data for multiple institutions. Retention has been the dominant mode of studying student success in engineering and higher education in general. However, studying who matriculates and who graduates does not tell the complete story of a student's path through the engineering curriculum nor should it be used as a measure of an institution. A national, longitudinal student unit-record database enables the study of engineering programs using consistent benchmarks and metrics. MIDFIELD has been used in high impact research on student matriculation patterns disaggregated across various engineering disciplines, ethnicities, and sexes as well as in exploring and promoting state of the art research methods. This project seeks to expand the number of institutions participating in MIDFIELD to enhance its value as a predictive tool. More details about the dataset are available in [1]. Information about the MIDFIELD team and research conducted using MIDFIELD is available on the MIDFIELD website [2]. As of November 1, 2021, 33 institutions have completed Memoranda of Understanding (MOUs) and nineteen institutions with ABET-accredited engineering programs have joined MIDFIELD.

A major effort in Year 6 was the development of a partnership with the American Society for Engineering Education (ASEE) that will separate data collection, database management, dataset distribution, and data archiving from the MIDFIELD research team. In addition to collecting student record information, we have compiled academic policy information for each partner institution. Other efforts in Year 6 include 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, we have developed and offered multiple workshops. In Year 6, we offered two workshops.

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.

Transitioning of MIDFIELD to ASEE

MIDFIELD aims to be self-sustaining. Thus, we are developing a partnership with the American Society for Engineering Education (ASEE) that will separate data collection, database management, dataset distribution, and data archiving from the MIDFIELD research team. Institutions may be more willing to share data in this manner rather than going through a specific institution such as Purdue University.

ASEE staff completed several planning activities to evaluate the transfer of the MIDFIELD database to ASEE. In coordination with the MIDFIELD team and the American Institutes for

Research (AIR), a technical plan was drawn up to allow for the transfer of the MIDFIELD database into ASEE's current Engineering Data Management System (EDMS). The plan includes the integration of the MIDFIELD into two current ASEE data collections: Profiles of Engineering & Engineering Technology Survey and the Engineering Retention and Time-to-Completion Survey. The proposed integration and transfer project would take place over two years. To facilitate the transfer, portions of the technical infrastructure were built, including an optimized database and prototype of a universal dashboard to facilitate the full exploration of the data.

In January 2022, the two-year transition project based on the planning work was awarded by the NSF. Over the next two years, the MIDFIELD team and ASEE will coordinate the transition of the on-going MIDFIELD data collection and database to ASEE.

Documentation of Institutional Policies

In addition to collecting student record information, we have compiled academic policy information for each partner institution and many prospective partners. We have collected and coded catalogs from each partner institutions to align with the time period of the data collected. For each partner institution and for each year they have contributed data to the MIDFIELD database, university catalogs have been coded 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 a pre-engineering status, admission to an engineering major, admission to engineering for less qualified students.
- 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.

Policy summaries have been completed for 40 institutions and are available to the public through our website [3]. As of January 18, 2022, 16 of these summaries have been downloaded over 125 times each by researchers interested in our work. The codebook is also available through our website 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.

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. For these activities, we have created an R data package, midfielddata, that provides a stratified sample of MIDFIELD data as a publicly available practice data set [4]. The practice data can be accessed and manipulated using midfieldr, an R package that provides tools for studying MIDFIELD student unit record data [5].

A workshop entitled "Engaging with MIDFIELD data" was presented at the 2021 ASEE Conference on July 26, 2021 [6]. Due to the COVID-19 pandemic, this was presented in an online format. About 15 participants registered and attended. At the beginning of the workshop, one participant reported not having installed R yet while the others had installed R, RStudio, midfieldr, and midfielddata. Participants were divided by their familiarity with R into breakout rooms for some activities.

At the conclusion of the workshop, participants were invited to complete a Likert-style survey. Eight participants responded—the distribution of their responses are shown in Figure 1. The top scale assists counting total agreement; the bottom scale assists counting total disagreement. The chart illustrates that respondents has a high level of agreement on all questions with only one "disagree" on each of 5 questions and no "strongly disagree" at all.
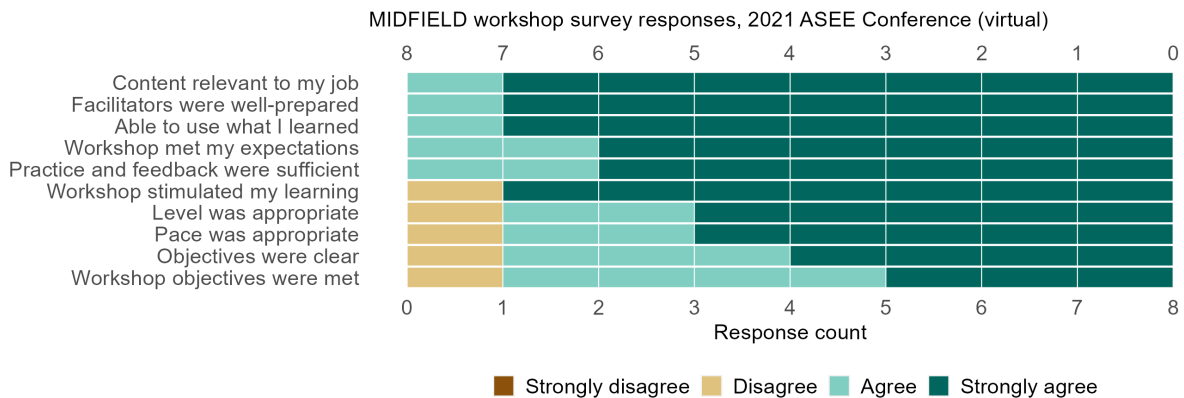

Figure 1. Post-workshop survey result.

When asked what the most valuable about the workshop, participants shared
- The most valuable part was having a person in the breakout room to help with difficulties in the code in real time and to answer different questions.
- Great assistance in the breakout rooms. I like how breakout rooms were organized by "learning level" - made it easier for me to catch up. Looking forward to diving into the dataset to explore more at some point. Thanks for a great workshop!
- The resources and discussion about data graphics and the stories they tell.
- The opportunity to see what type of data can be accessed and the emphasis on using the data to find the "story."

Participants provided several ideas for improving the workshop including improving pre-workshop communication, organization, and increasing the amount of content while speeding up the pace and making it more difficult. Others suggested

- I would like to go through the details of the specific functions and examples of how to use them.
- Looking forward to being in person again :-)
- The familiar with R breakout room was very quiet as we were working independently so there wasn't much chance to learn from each other. It might be helpful to have 'check-ins' that require participation and for participants to speak to.
- For the first example with the case that we follow a little R to show how to actually get the table would be nice. I used the web browser table but I felt like I could have made them on my own but I couldn't quickly figure out how to call the singular ID from all the data for certain things (I am rusty on R but I wanted to try and do it this way for "practice")

Feedback from this evaluation will be used to improve subsequent offerings.

We presented a special session at the 2021 Frontiers in Education (FIE) conference in October. This was in a hybrid format with the facilitators and some attendees online and other attendees in person [7]. The hybrid format was particularly challenging since the internet access in the conference room was insufficient for the in-person participants to connect to our online materials and they all had to share. We had about 10 participants total. Only two participants filled out the evaluation. Overall, their evaluation was positive regarding meeting expectations, content being relevant to job, clear objectives, workshop activities giving sufficient practice and feedback, and facilitators being well prepared. Suggestions for improvement included faster pace, more content, more time for the workshop, more difficult activities, and more stimulating activities.

Dissemination

Despite the COVID-19 worldwide pandemic, the MIDFIELD team has continued to disseminate results from research using MIDFIELD in Year 6 in various venues including conferences and invited talks [8, 9]. At the 2021 ASEE Annual Conference, we presented a summary in the NSF Grantees session [10]. At the 2021 EDUCON conference [11], we presented research comparing international and domestic students in engineering. The abstract summarizes the work as follows

> This study focuses on quantitative analyses of international and domestic students pursuing undergraduate degrees at institutions in the USA. Metrics used include representation at start of university studies, representation at graduation and six-year graduation rate. Results are disaggregated by origin (domestic or international), sex (female and male), and major (engineering or non-engineering). Results show that more international students choose engineering than other majors. There are more men than women in engineering and this is more pronounced for international students. International students graduate at higher rates in engineering than domestic students by about 5%. This may reflect a tension between their higher academic qualifications but challenges of adjusting to studying in another country. These insights can be used to support student success.

We were invited to expand our FIE 2020 Special Session paper for inclusion in a special issue of *IEEE Transactions on Education* celebrating the 50th Anniversary of the FIE Conference. This is now available at [12]. As described in the introduction, "In this paper, we present the history of MIDFIELD and an overview of the current dataset including data structures, student data, and policies data. This is followed by an introduction to MIDFIELD researchers and efforts to expand the network of scholars using this resource. We provide highlights of studies conducted using MIDFIELD and feature some on-going research. MIDFIELD is a unique resource offering student record data at an unprecedented scale. We hope that by understanding what data is available in MIDFIELD, the types of research that are possible with it, and how to access it, more researchers may decide if this is a useful resource for their own investigations."

Impact

Dr. Corin Bowen attended our FIE 2021 MIDFIELD special session and shared that she had used our MIDFIELD work on Aerospace Engineering [13] in her work on Aerospace Engineering at the University of Michigan as part of her dissertation [14]. She highlighted that our research was the only work she could find that disaggregated by discipline, race, and sex.

Co-PI Lord was invited to be one of the Faculty Scholars Network who presented to the NSF-funded Establishing New Generations of scholars to Amplify and Grow Engineering Education (ENGagED) Research Experience for Undergraduates (REU). Her seminar presentation featured work with MIDFIELD that led to the 2019 *Journal of Engineering Education* Wickenden award-winning paper. This REU grant is a collaborative research grant awarded to Dr. Brooke Coley at Arizona State University (2050899) and Dr. Denise Simmons at the University of Florida (2051156) and entitled "Establishing New Generations of scholars to Amplify and Grow Engineering Education (ENGagED)." [15, 16]

Acknowledgments

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