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Matthew Ohland
Purdue University

Clemencia M. Cosentino
Mathematica Policy Research

Catherine E. Brawner
Research Triangle Educational Consultants

Catherine Mobley
Clemson University

Russell A. Long
Purdue University

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Dr. Matthew W. Ohland, Purdue University

Matthew W. Ohland is 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 over $14.5 million from the National Science Foundation and the Sloan Foundation and his team received Best Paper awards from the Journal of Engineering Education in 2008 and 2011 and from the IEEE Transactions on Education in 2011. Dr. Ohland is Chair of the IEEE Curriculum and Pedagogy Committee and an ABET Program Evaluator for ASEE. He was the 2002–2006 President of Tau Beta Pi and is a Fellow of the ASEE and IEEE.

Dr. Clemencia M. Cosentino, Mathematica Policy Research

Clemencia Cosentino (Ph.D., Sociology, Princeton University), a Senior Researcher and Area Leader at Mathematica Policy Research, is the former director of the Program for Evaluation and Equity Research at the Urban Institute. Over the past 20 years, her work has focused on evaluating efforts and studying factors that influence the participation of underrepresented groups in STEM.

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, teacher 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 departments on diversifying their undergraduate student population. Dr. Brawner previously served as principal evaluator of the NSF-sponsored SUCCEED Coalition. She remains an active researcher with MIDFIELD, studying gender issues, transfers, and matriculation models in engineering.

Dr. Catherine Mobley, Clemson University

Catherine Mobley, Ph.D., is a Professor of Sociology at Clemson University. She has over 20 years experience in project and program evaluation and has worked for a variety of consulting firms, non-profit agencies, and government organizations, including the Rand Corporation, the American Association of Retired Persons, the U.S. Department of Education, and the Walter Reed Army Institute of Research. Since 2004, she been a member of the NSF-funded MIDFIELD research project on engineering education; she has served as a Co-PI on three research projects, including one on transfer students and another on student veterans in engineering.

Mr. Russell Andrew Long, Purdue University, West Lafayette

Russell Long, M.Ed. is Director of Project Assessment at the Purdue University School of Engineering Education and 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.

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Major Goals

1. ***Understand the transfer population by answering the following question:***

Q1: What are the demographic / academic characteristics of engineering transfers?

2. ***Define the educational paths taken by transfer students by answering the following question:***

Q2: What paths do engineering transfers take to graduation and other outcomes?

3. ***Explain how transfer student outcomes occur by answering the following question:***

Q3: What student, program, and institutional factors are associated with educational outcomes (graduation, time to degree, drop out, etc.) in engineering?

4. ***Explore why transfer student outcomes occur by answering the following questions:***

Q4a: Why do students choose to transfer?

Q4b: How do transfer students adjust and what climate do they find?

To answer these questions, we use a mix of qualitative and quantitative methods.

Major Activities

We improved the MIDFIELD database by creating a variable that identifies the type of institution from which a student transferred—2- versus 4-year. There are no missing values in this variable due to a combination of data obtained from partner institutions and the creation of a crosswalk table that allowed us to convert all institution codes to a consistent format that could be linked to institution type.

This year, we refined our quantitative analysis by modeling transfer student success including the type of institution from which students transfer. This was critical to avoid publishing misleading results as we discovered that the two transfer pathways – transfer from a 2- versus a 4-year institution – had very different characteristics associated with the outcomes of interest, such as graduation.

We made progress on our qualitative analysis by using interview data to study the decision to pursue engineering studies through the transfer pathway and completing three papers. We leveraged interviews with four veterans among the 86 transfer student interviews to initate a separate project to study veterans in engineering.

We contributed to building the STEP community by leading a breakout group on evaluation at the 2014 STEP Grantees Meeting. This breakout reviewed well and was repeated as a webinar. We expanded our reach to other researchers studying transfer students by presenting findings on transfer shock to the National Institute for the Study of Transfer Students.

Significant results

From *Identifying and Describing the Entry Points into Engineering Transfer Pathways:* A preliminary study relied on 52 of the 86 students who were interviewed across five campuses to understand their reasons for choosing engineering as a field of studies and the transfer pathway to enter the field.

- The college decision process is complex and deserves further analysis. By learning more about the diverse educational pathways educators can more explicitly design programs to attract more students into engineering.
- Even among students who had already declared a major in engineering and who had already transferred, many students did not always pursue a straightforward path into and through the engineering pathway. Students varied in their level of intentionality and clarity regarding their choice of engineering as a major and the choice to enter as a transfer student.
- Student decisions take place within a specific individual, institutional, and even, political context. For example, states have developed different policies that encourage (or discourage) certain types of decisions and pathways.
- As this analysis continues, the team will investigate the importance of social capital and institutional support in transforming one's decisions about their college major or to attend one school over another. We will also investigate how various sociodemographic characteristics, such as gender and race, shape student decisions as these factors impact the likelihood of choosing one path over another and students' intentions to transfer.

From *Studying the Motivations and Experiences of Older Transfer Students in Engineering:* Of the 86 students who were interviewed on the five campuses, the 15 students who were 25 years of age or older at the time of the interview were selected for this study.

- For these older transfer students in engineering, choosing to return to school and to major in engineering was primarily driven by economics.
- Economic factors also affected the choice of where to attend school—specifically, proximity and cost. Most chose to start at relatively inexpensive local community colleges; those who attended four-year schools prior to transfer did so with financial assistance that made it tuition-free to them. The choice of MIDFIELD institution was related to proximity, cost, and reputation in engineering.
- These students had to learn to navigate a system in institutions that focus on serving students of more typical age and that often subsequently ignore students who do not fit into that mold.

- The rhythm of undergraduate life is not in sync with students who commute or have families and other interests away from campus, yet the older students made the necessary adjustments to pursue their studies and accommodate their other interests.
- Students with families in particular needed to balance their academic and family lives causing them to make choices about whether to commute or live apart from their families; attend full time, part-time, or with a reduced course load; and whether to pursue co-op and internship opportunities or graduate sooner and enter the workforce.
- Many of the students had attended college immediately after high school and left due to poor academic performance, poor fit, or to have families. On return to college, they were much more focused and academically successful.
- The maturity and practical experience of the older students allowed them to relate more to what they were learning, but they did have to overcome academic deficiencies, particularly in math.

From *Studying the Performance of Black transfer students:* based on a logistic regression model refined to include transfer pathway (2-year vs. 4-year), we learned that:

- The two-year transfer pathway is an effective means of earning a four-year degree in engineering for Black students. If Black transfer students from 2-year schools are not successful in four-year engineering programs, it is likely due to other factors associated with achievement, not transfer status.
- Specifically, we found that:
    - Transfer status is not a significant predictor of performance or achievement for Black students
    - Gender is significant across model specifications and the relationship with outcomes is consistent: Black females outperform and outpersist Black males
    - While Black 4-year transfers outperform Black 2-year transfers, it is because transfer status is correlated with other student characteristics, particularly gender.
- We are currently refining our models to include interactions, such as transfer status with gender, and preliminary results do not alter conclusions reported here

From *Studying the Mean Grade Differential by Course Discipline:* For engineering transfer and first-time-in-college (FTIC) students, we computed average grades in STEM courses by discipline, and by institution.

- There were clear institutional differences in the general performance of transfer students relative to FTIC students.
- Within an institution, there were clear differences by discipline in the performance of transfer students – for all the subjects we considered, we found that transfer students outperformed FTIC students in at least one institution.
- At no institution did transfer students outperform FTIC students in all subjects, but transfer students at one institution underperformed FTIC students in all subjects.
- Transfer students most consistently underperformed FTIC students in Computer Science and Physics courses.
- Aggregated over all institutions and disciplines, the grades of transfer students and FTIC students are not meaningfully different.

Training and professional development

- Mobley and Brawner attended a 3 ½ day qualitative data analysis workshop, Wilmington, NC, November 2013 covering a variety of topics including how to manage a qualitative project, prepare graphic displays of qualitative data, distill findings, use qualitative software in a team environment, and manage data.
- As a result of this workshop, the qualitative team made significant progress on developing episode profiles for all 86 in-depth interviews. These profiles are an instrumental dimension of our more in-depth qualitative analyses.

Plans for the next year

Integrate quantitative and qualitative findings to identify a creative way of operationalizing transfer shock / GPA shock that is unbiased.

Examine the differences between traditional and non-traditional students in their levels of engagement and integration into the MIDFIELD institution and further explore the social and cultural capital that the students both bring and lack. Research suggests that non-traditional students participate in academic life differently and that these styles of engagement influence attrition rates. Integrating findings from this project with an independent study of non-traditional students will deepen our understanding of older students, only some of whom are transfers.

Focus a current manuscript-in-progress on first-generation engineering transfer students and the role of two-year colleges in facilitating transitions to four-year institutions. First-generation students are more likely to begin their college careers at a two-year colleges and two-year colleges are an important source of engineering majors. This paper uses an asset-based approach and social capital theory to understand and explain academic persistence and student outcomes.

Extend the study of performance and persistence of Black transfer students to students of all racial and ethnic backgrounds. This work is ongoing and will rely on linear and logistic regression models of several outcomes of interest, such as academic performance (using GPA, failing a course, and so on) and achievement (graduation, graduation within six-years, graduation in engineering, and so on).

What is the impact on engineering education?

Gaining a deeper understanding of the transfer pathway to engineering touches on a variety of issues of importance to the engineering community. The transfer pathway represents: an opportunity to increase the number of engineering graduates to meet a growing need; an opportunity to promote socioeconomic equity in the profession by offering a more economical pathway to an engineering degree and potentially high-paying employment, and the potential to increase the gender and racial/ethnic diversity of the field. This potential can only be reached if

universities expand the pool of transfer students, because although two-year institutions are much more diverse than four-year institutions, the population of those who actually transfer to four-year institutions is demographically similar those who matriculate directly to those four-year institutions (in engineering and in the aggregate). Our particular contribution to research in this area derives from our ability to conduct large-scale descriptive and longitudinal studies as well as by our ability to conduct qualitative studies informed by that unique quantitative resource.

Findings from interviews with military veteran students who are transfers motivated a separate study of veteran students in engineering to take advantage of a potential pipeline of qualified and diverse students and to learn more about their unique needs and gifts in higher education generally and engineering specifically.

The 86 interviews with transfers, combined with 61 interviews with sophomores funded separately through a related project, provide a resource that can continue to be studied in different ways, for instance, in the study of the attraction and retention in the various engineering disciplines or the effectiveness of advising.

What is the impact on other disciplines?

The application of the stickiness metric—which measures the likelihood of a student graduating in a major once they enroll in it—will be useful beyond engineering because it allows a greater diversity of students to be included than typical persistence rates. It can be used in any discipline to determine how "sticky" the discipline is to different groups of students or how "sticky" it is overall compared to students of other disciplines at the institution. This new metric is not biased by the multitude of matriculation schemes that exist (described in the findings section).

What is the impact on the development of human resources?

Strengthening the transfer pathway would improve the diversity of the engineering student population and the engineering profession. Studies of where transfer students come from might simultaneously reveal opportunities for new sources of transfer students and clarify where students who currently transfer come from. This latter finding can help institutions make targeted efforts where resources are in short supply. As our findings describe successful strategies for supporting transfer students, a larger fraction of engineering transfer students will earn engineering degrees, allowing them to fulfill their academic and economic potential.

What is the impact on information resources that form infrastructure?

The stickiness metric has the potential to improve institutional research in a wide variety of contexts. The metric allows pooling data not only from multiple institutions and cohorts, but also allows pooling data from different pathways—FTIC, transfer, students who matriculate directly to a discipline, and students who pass through a first-year engineering program. In so doing, the stickiness metric allows researchers to construct larger and more representative samples that increase the power of studies and avoid the biases that result from cohort studies that only include first-time-in-college students that matriculate in the Fall semester.

What is the impact on society beyond science and technology?

Given demographic trends, minorities are not only the group from which growth in STEM is expected, but they are a population of growing importance in other fields as well. Minorities are more likely to begin their studies at 2-year colleges than nonminority students. In studying transfer students, even though we are focused on students in engineering, some of what we are learning may apply to transfer students in general (i.e., things that are universal for this population), not just those in engineering. For instance, supporting students after they transfer and helping them to develop cohorts in their disciplines can be useful in many disciplines. In that context, this study should yield findings relevant to other fields in STEM and beyond STEM.

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