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A Descriptive Study of Engineering Transfer Students at Four Institutions: Comparing Lateral and Vertical Transfer Pathways

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A Descriptive Study of Engineering Transfer Students at Four Institutions: Comparing Lateral and Vertical Transfer Pathways

Students who attend two or more institutions during their post-secondary educational careers, or transfer students, make up just over one-third of all American students.[1] Additionally, 25% of students who transfer will do so more than once.[1] Reasons for transfer vary widely, but usually include academic, financial, or institutional factors.[2] Moreover, reasons for transferring may be different from reasons for discontinuing coursework until a later date (stopping-out), as those who stop-out normally identify more personal reasons for leaving an institution compared to the academic reasons students provide for transferring from one institution to another.[2, 3]

No matter the reasoning, transfer students account for a large proportion of all students, and their experiences at the new institution may be different from native students, those students who have started and remained at the same institution. Policymakers should consider such differences, as transfer students demonstrate lower retention[4] and graduation rates[5] than native students. In order to increase student retention and completion, it is important to better understand how the various kinds of transfer students may differ from one another, based on program of study, type of sending institution (i.e., two-year versus four-year), and type of transfer pattern (i.e. two-year to four-year versus four-year to four-year).

In this paper we explore the educational pathways and characteristics of a sample of engineering transfer students at four institutions who are participating in a broader mixed-method study of the pathways, persistence, and outcomes of transfer students in engineering. The larger study is part of an ongoing series of research studies using the Multiple Institution Database for Investigating Engineering Longitudinal Development (MIDFIELD). MIDFIELD is both a database and a partnership among 11 participating institutions with engineering colleges, predominantly, but not exclusively, in the southeastern United States. The database consists of student record information for students attending the partner schools from the 1987-88 to the 2009-10 academic years, although not all institutions contributed data in all years.

The descriptive study reported here is based on the qualitative portion of the MIDFIELD project. We present information about the transfer pathways of students, the presence of articulation agreements, and the presence of "GPA shock" using data collected from 126 interview volunteers.

Literature Review

Engineering Transfer Students

The typical college experience is no longer one in which a student completes his or her baccalaureate journey in a timely four years at the same institution in which he or she was initially enrolled. Instead, one-third of all American college students have attended more than one institution during their post-secondary educational careers.[1] When considering research on transfer student performance and retention, separating transfers by major may be an important distinction. Presently, the United States is in dire need of more engineers, scientists, and technologists.[6] Although the total number of bachelor's degrees awarded between 2003-2004 and

2007-2008 rose 11%, the number of engineering and computer science bachelor's degrees awarded declined 11% during the same period.[7] Not only is the engineering pool shrinking in the United States, but other countries such as China are consistently producing engineering and technology graduates, jeopardizing the United States' position in the global engineering and technology hierarchy if policymakers do not take swift action.[8]

Numerous studies have focused on methods for increasing the number of students majoring and matriculating in the various engineering disciplines. In particular, several sources have noted that students in community, junior, and technical colleges represent a valuable source of engineering potential.[9, 10] While the transfer population is already large enough to be of interest as a source of engineering graduates, curriculum and financial trends are likely to increase the number of students in that pathway. This research stream focuses on the need for remedial coursework and financial assistance in order for students to complete their studies. Thus, two-year colleges are viewed as the starting point for these students' educational pathways that include matriculation to a four-year university (vertical transfers). However, we contend that research needs to expand to include other pathways, in particular the transition from four-year to four-year institutions (lateral transfers).

Lateral Versus Vertical Transfer Pathways

Even though researchers do pay attention to the importance of recruiting engineering students, especially women and minorities,[11, 12] many of the studies that focus on transfer students in engineering emphasize the two-year to four-year transition, as "community colleges are an especially attractive source of prospective engineering students" (p.7).[9] Yet this so-called "upward" or "vertical" transfer is not the only viable educational pathway, and some suggest it is not even the most common.[13]

Other types of transfer combinations include "horizontal," or "lateral," transfers – those students who start at one institution and transfer to another institution of a similar type (either two-year to two-year or four-year to four-year).[2,13,14,15] Further, reverse transfer occurs when a student begins at a four-year institution and transfers to a two-year community or technical college.[13,14,16,17] To complicate matters further, researchers coined the terms "student swirl" and "double-dipping" to represent transfer students who return to their original institution at some point or enroll concurrently in multiple institutions, respectively.[18] Thus, although much of the literature on transfer students focuses on the vertical transfer pathway, the variability in transfer pathway types calls for a closer look at other pathways, especially the lateral, four-year to four-year track.

Research suggests that there are distinct reasons for lateral transfer as compared to vertical transfer. The pattern of lateral versus vertical transfer may be related to a particular student's financial situation.[13] It could be that lateral transfers are those students who are more likely to be experimenting with college or trying out different options before committing to a particular educational pathway.[14] At the same time, Bahr[14] concludes that lateral transfers may be more strategic and purposeful in their educational decisions, a conclusion supported by the finding that lateral transfer within community colleges is most likely at the beginning of a student's path in the system when the student may be experimenting or exploring options but less likely once the student reaches the 60-credit mark, which is the typical requirement for an associate's degree or

the recommended number of hours before transfer to a four-year institution. Tinto's[19] research posits that four-year lateral transfer students view the first institution as a "stepping stone" to the often more prestigious second institution. That is, they do not transfer because of academic failure at the first institution.

There are also some key differences in the needs and outcomes of students who transfer from two-year institutions versus those students who transfer from four-year institutions.[20,21,22] Thus, recognizing the differences between transfer pathway types (i.e., lateral versus vertical transfer pathways) may be essential to improving the transfer student experience. Given that so many students attend more than one institution throughout their educational career, it is in the best interests of practitioners, faculty members, advisors, and administrators to consider the unique challenges and demands that transfer students face in order to design orientations, workshops, and programs that meet their specific needs.[23] Additionally, a better understanding of student flow within engineering majors may reveal recruitment and retention strategies for the field of engineering, which could enhance the draining pool of candidates in the United States.

Articulation Agreements Facilitate the Transfer Process

Another factor that can expand understanding about transfer pathways is the existence of articulation agreements between higher education institutions. Articulation agreements and dual-degree programs were created to improve student transitions from one institution to another. With an articulation agreement, schools agree on the transfer of credits into particular programs. Many states have created statewide articulation agreements among public institutions to facilitate transfer among those states' institutions and some have common course numbers across participating institutions to eliminate the guesswork that is sometimes involved in the transfer of credits. The presence and strength of articulation agreements and common course numbering systems is viewed as particularly important for engineering students.[24]

Additionally, a few articulation options were particularly relevant to our current study. In a dual degree program, also known as a 3+2 program, a student attends approximately three years at the first institution and then transfers to the receiving institution for an additional degree. The student ultimately receives degrees from both institutions. For instance, a student may receive a Bachelor of Arts degree in math from the sending institution and a Bachelor of Science degree in an engineering field from the receiving institution. In a 2+2 program, a student may receive an associate's degree from the first institution before transferring to the receiving institution for a bachelor's degree. Despite the development of the articulation agreement and dual degree systems, considerable confusion about acceptability and applicability still exists.[25]

Much of the research on articulation agreements has tended to focus on vertical transfers rather than four-year lateral transfer students and policies, including a recent major overview of "promising practices" in statewide articulation and transfer systems.[26] This research bias makes sense given that most articulation agreements are between two-year and four-year institutions. The relative lack of articulation agreements between baccalaureate granting institutions means that four-year lateral transfer students experience more conflicts than vertical transfer students.[27]

Student Outcomes and Transfer Shock

Research on the effects of transferring on student outcomes is mixed. On one hand, studies show that transfer students' grade point averages (GPAs) are lower during their first year after transfer when compared to "native" students who persist at the same institution in which they initially enrolled.[5, 28] Hills[29] coined the phrase "transfer shock" to refer to this dip in academic achievement after transitioning to a new institution. Further, transferring is associated with lower retention and graduation rates than remaining at a single institution for the duration of one's educational career.[5] In particular, engineering students who transfer to a four-year university face unique challenges in adjusting, including rigid prerequisite requirements,[30] inadequate preparation for upper division courses[31] and self-initiated advising.[32] Transfer shock is worse at research universities[33] and more intense for technical students than students majoring in non-technical fields.[34] Given the diversity of student outcomes associated with transferring from one institution to another, we prefer to use the term "GPA shock" when describing what happens to student grades after they transfer (versus "transfer shock," a more general term that could encapsulate a broader diversity of post-transfer student outcomes).

Other research indicates that transfer students perform as well as, and in some cases, better than, native students. In a study of 100 community college transfer students and 100 native students in the College of Arts and Sciences at a public, southeastern university, Glass and Harrington[35] found that after one year at the receiving institution, native and transfer students' GPAs did not significantly differ. Upon graduation, students who had transferred from the community college earned the same or better GPAs than the native students.[35] Similarly, some studies have found that students in certain majors who transfer to a new institution earn better grades than they did at their previous institution.[36,37] Nickens[38]coined the term "transfer ecstasy" to refer to those transfer students who experience an increase in their GPA after a semester or two at their receiving institution.

Cejda et al.[37] add support to the claim that transfer shock and GPA recovery may differ according to academic major. Using information gathered from community college transfer students who had earned an associate's degree, the authors classified students' majors at their receiving institution (a private, liberal arts college) into four areas: fine arts and humanities (students majoring in art, music, theater, English, foreign language, history, or religious studies); mathematics and science (those majoring in physics, chemistry, mathematics, or biology); social sciences (including majors in psychology, sociology, economics, or government); and the professions (majors in business administration, elementary education, or journalism). After comparing changes in GPAs from the community college to the private, liberal arts college by major, Cejda et al.[37]found that the only significant difference was for mathematics and science majors, who experienced an average GPA decline of .272 in their first semester. Interestingly, students in the fine arts and humanities and social science disciplines experienced "transfer ecstasy," although the increases were not statistically significant.

There may also be differences between lateral and vertical transfer students in GPA and other student outcomes. Specifically, in a study of one-time transfers who were non-science and non-professional majors, Kirk-Kuwaye and Kirk-Kuwaye[15] found that vertical transfer students scored higher than lateral transfers on three out of four measures of engagement: active and

collaborative learning, a supportive campus environment, and enriching educational experiences. The lateral transfer students scored higher than vertical transfers on the student-faculty interaction measure. The authors conclude that because of the inconsistency in culture and academics between two- and four-year institutions, students making the vertical transfer are perhaps forewarned by their sending institutions to expect significant differences; thus, they may be more prepared and willing to put forth more effort to make an adjustment than students going from one four-year school to another.[15] Additional research supports this idea that vertical transfer students fare better than four-year lateral transfer students. Kocher and Pascarella's[39] research on lateral transfer students found that this transfer pathway resulted in negative outcomes, in terms of both educational attainment and employment status, for both black and white transfer students.

On the other hand, culture shock theory suggests that individuals who transfer from one four-year institution to another four-year institution may actually fare better than vertical transfers (from a two-year to a four-year institution). As suggested by Laanan,[40] vertical transfers are more appropriately thought of as "sojourners" who must adjust or adapt to the signs and symbols of a foreign environment. We posit that lateral transfers may have an easier time transitioning from one environment to the next because they encounter more familiar cues; that is, they are already used to the academic life of a four-year institution. Thus, for students transferring from a two-year community college to a four-year institution, transfer shock may be explained by the differences in academic rigor, class and campus size, and university culture at the new institution.[41]

Background of Our Study

The present paper is part of a larger, mixed-methods study involving a longitudinal analysis of the academic pathways of engineering undergraduate transfer students in the MIDFIELD partnership. The overarching goal of the larger study is to enhance understanding of transfer student characteristics and how transfer students may differ from native students in order to determine which factors lead to the most successful outcomes for students in engineering majors.

The quantitative portion of this MIDFIELD study involves statistical analyses of transfer student records from the MIDFIELD institutions. The MIDFIELD database includes records for approximately 210,000 undergraduate students who matriculated into engineering, approximately 45,000 of whom were transfers, at eleven public institutions between 1987 and 2009. In this study, we restrict the transfer population further to include only US citizens and permanent residents whose first major after transferring is an engineering major, which yields 31,262 students.

Qualitative techniques for the MIDFIELD study on transfer students will ultimately include semi-structured interviews with approximately 90 undergraduate engineering students at five of the eleven partner universities to get a fuller picture of the motivations to transfer and challenges transfer students face. The present paper includes a descriptive analysis of transfer pathways using data from survey respondents at the first four institutions visited.

Methods

Descriptive data for this paper were taken from responses to a recruitment questionnaire answered by transfer students in engineering majors at four of the eleven MIDFIELD institutions. In Fall 2011, Spring 2012 and Fall 2012, representatives from the four schools sent an email to transfer students who, according to university records, were majoring in chemical (with biomolecular at some schools), civil, computer, electrical, industrial, or mechanical engineering, inviting them to volunteer for a semi-structured, in-person interview and informing them about the $20 incentive for participating. Interested students were directed to a qualification survey on Survey Monkey™ that asked for demographic information, academic history, contact information, and interview availability. The demographic and academic history data are the focus of the present study.

Students who answered the survey were eliminated from this analysis if they reported that:

- They already had earned a bachelor's degree from an institution other than one that was part of a dual degree program where a bachelor's degree was expected as part of receiving the engineering degree (i.e., a 3+2 program);
- They had a degree or transferred from a non-US institution;
- They did not have a major in chemical, civil, computer, electrical, industrial, or mechanical engineering or general engineering (which is the required major for new transfers at one school until the students have successfully completed certain prerequisite courses).

For survey participants contacted during the 2012-13 academic year (N=66), questions were added about the parents' highest level of educational attainment and whether the student attended school on a full-time or part-time basis. Some responses were adjusted to reflect factors known to the researchers but improperly reported by the respondents, such as whether a particular community college had a formal 2+2 program with the MIDFIELD institution.

Data on students' most recent sending institutions were classified according to in- or out-of-state status (compared to the state in which the receiving institution resides), as well as whether the sending institution was a two- or four-year school. To determine two- or four-year status, the online Carnegie Institution Classification[40] was consulted, an approach used by other researchers.[15,42,43] Schools on the Carnegie website are classified according to the most recent information, which was last collected in 2010. Schools that may offer bachelor's degrees but were classified as "associates dominant" by the website were considered two-year institutions for the purposes of this study. Additionally, students were categorized according to whether or not they participated in an articulation agreement. If the receiving institution was in a state where statewide articulation agreements exist for public institutions, then a student who transferred to this institution from another state institution was classified as having participated in an articulation agreement, whether or not they explicitly reported this on the recruitment questionnaire.

In this analysis, the use of the term "MIDFIELD" refers to all of the student records from all 11 schools; the "selected schools" consist of all MIDFIELD data for the four schools from which the current study population was drawn; and the "study population" consists of the 126 qualified

respondents to our survey. The four selected schools represent 52.6% of the US Citizen/ permanent resident transfer population in MIDFIELD who are majoring in chemical, civil, computer, electrical, industrial, mechanical, and general engineering. The overall gender balance in engineering of the four selected schools, with 18% women and 82% men, is representative of the MIDFIELD population as a whole ($\chi^2 = 1.29$, d.f. = 1, n.s.). Relative to the population of engineering students in MIDFIELD, the population of the four schools in this study is: slightly more Asian (9% to 7.7%), less Black (12.4% to 16.5%), more Hispanic (6.4% to 4.7%) and less white (70% to 66.9%).

Results

Description of the Study Sample

The study sample consisted of 126 respondents to the qualification survey who were not excluded for one of the aforementioned reasons (67 students were ultimately interviewed). Table 1 depicts the sex, race and major of the study sample. The study sample is representative of the population at the selected schools by sex and race ($\chi^2_{sex} = 2.02$, d.f. = 1, n.s.; $\chi^2_{race} = 9.95$, d.f. = 5, n.s.).

Table 1. Sex, Race and Major of Study Sample

Race/Sex	CE	CHE	CPE	ECE	EE	FYE	IE	ME	Total
White male	10	9	2	1	12	6	4	28	72
White female	2	7		1	2	2	3	3	20
Asian male	1	1			1		1	4	8
Hispanic male	2		1		2		1	2	8
Hispanic female	3	2		1					6
Black male			1	1	1	2		1	6
Black female	1				1			1	3
HN/PI male	1								1
Mixed male								1	1
No response male								1	1
All male	14	10	4	2	16	8	6	37	97
All female	6	9		2	3	2	3	4	29
All students	20	19	4	4	19	10	9	42	126

The average age of the respondents was 22.3 years with 23 respondents (19%) indicating that they were 25 years old or older. These students, therefore, are a bit older than typical college students who would have started immediately out of high school and would have been expected to graduate by age 22. Forty percent classified themselves as juniors, 39% as seniors, and 20% as sophomores at the time of the survey. One student was a freshman. Forty-three of the 126 respondents (34%) reported that they attended more than one other institution prior to transfer. Only four part-time students were among the sixty-six students who were asked about their status. This substantially underrepresents part-time students who make up 35% of the population at the selected schools. We surmise that part-time students may have been too busy with work or family responsibilities to have the time to participate in our study. Ten of the 66 students (15%) who were asked about their parents' education appear to be in the first generation in their family

to attend college; that is, neither their mother nor their father reportedly attended college (we have no information about siblings). However, on the whole, the parents of the respondents were well educated, with 42 of the 66 having at least one parent with a bachelor's or graduate degree.

Mechanical engineers are substantially overrepresented (32%) compared with the population at the selected schools (20%), while first-year engineering (8% vs. 15%) and electrical/computer engineering (21% vs. 31%) are substantially underrepresented. Chemical is the most popular engineering major among our sample of female transfers, with almost a third of them (9/29) choosing it for their major. Thirty-eight percent of males in this study chose to major in mechanical engineering, making it the most popular choice for males. Nearly half of all chemical engineering majors in the study group are women compared with 10% of all mechanical engineering majors.

Lateral Versus Vertical Transfer Pathways

Although most of the literature concerns vertical transfer, or the move from a two-year to a four-year institution, in our sample, 46% of the students come to the four-year receiving institution from other four-year schools. This indicates that the literature may disproportionally represent vertical transfers while neglecting other transfer pathways. The mosaic plot in Figure 1 and data in Table 2 show that most transfers, both from two-year and four-year, come from institutions in the same state as the MIDFIELD (receiving) school and that most schools from which students transfer have a formal articulation agreement with the MIDFIELD school (Note: See Appendix A for information on interpreting mosaic plots).

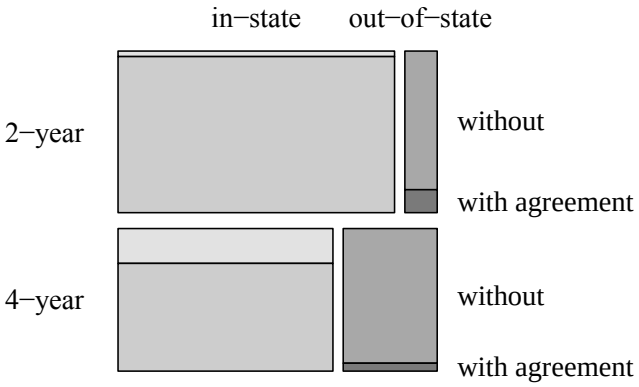

Figure 1. Relative proportions (mosaic plot) of institutional characteristics in Table 2. The area of each "tile" is proportional to the percentage of institutions with the characteristics indicated. A tutorial on mosaic plots is appended to the paper.

Type	In-state with, w/o	Out-of-state with, w/o	Totals
2-year	58, 2	1, 6	67
4-year	31, 10	1, 17	59
Totals	101	25	126

Table 2. Frequency of characteristics of the institutions attended by the 126 study participants(contingency table). Agreement status is indicated "with" or "w/o" (without).

Male students in our sample are more likely to come from a two-year school (56%) than female students (48%). Hispanic students are also more likely to come from a two-year school (71%) than any other ethnic group (Asian – 18%; Black – 33%; White – 55%).

Presence of Articulation Agreements

Among the seven states with MIDFIELD schools, three have enacted statewide articulation agreements, either among all public higher education institutions or from two-year to four-year institutions. In one of the three states, students who complete an associate's degree at a community or other state college or university are given preferential admission at public, four-year institutions. Furthermore, some states have created "transfer blocks," or sets of courses that are often taken at a community college, which will transfer to a particular program if the student has earned passing grades in all the required courses. Five states with MIDFIELD institutions have established transfer blocks for engineering; two of them include the engineering transfer blocks as part of the associate's degree, and students with satisfactory GPAs are guaranteed admission to the MIDFIELD engineering schools in those states.

Table 3 in Appendix B shows the range of agreements from various institutions with the selected schools. Transfers from out-of-state are much more likely to come from schools without a formal articulation agreement in place, although it is worth noting that these MIDFIELD schools have made agreements with schools across state lines. Institution 1 has been most aggressive in developing agreements with most schools in its state system as well as private schools, particularly HBCU's, both in-state and out-of-state. Agreements include a Formal Transfer Program (FTP) with other public institutions in State 1 as well as 3+2 programs with both public and private institutions. Institutions 2 and 4 are located in states where statewide agreements are in place among all public institutions, although institution 4 also has agreements with some private schools in its state and private HBCUs in State 1. There is a transfer block in State 3 to Institution 3 from all public community colleges, but Institution 3 has also developed a number of 3+2 agreements with private in-state colleges and a few other institutions in neighboring states. Both Institutions 3 and 4 have developed a particularly strong relationship with the nearest community college that includes site visits to the local community college by representatives from the College of Engineering.

The Presence of Transfer Shock

The literature regarding transfer shock (or, more appropriately, "GPA shock") is supported in large measure by our sample. Using broad grade ranges (<2.0; 2.0-2.49; 2.5-2.99; 3.0-3.49; and 3.5-4.0), half of the respondents reported lower GPAs at the MIDFIELD school at the time of the survey than they had earned at their prior institution, 45% of respondents had GPAs in the same range at their MIDFIELD school as they did at their prior school, and 6% experienced "transfer ecstasy," having higher GPAs at the MIDFIELD school than at the sending institution. (Five respondents were in their first semester and therefore had no GPA at their current school and were not included in this part of the study.) We note that students were surveyed at different points in their transfer experience, though generally within one year of enrollment at the MIDFIELD school. Thus, some students had more time to "recover" from GPA shock than others.

Figures 2 and 3 show that for both two-year and four-year transfers, students entering with lower GPAs (2.5-2.9) tend to have GPAs in the same range or better at their new school; few experience transfer shock. Students entering with a 3.0 to 3.49 are as likely to experience GPA

shock as not. However, for students who had high GPAs at their prior institution, GPA shock is more prevalent among the two-year transfers. This might indicate that transfers from other four-year institutions are better prepared for the workload than students transferring from two-year institutions, but these data are not conclusive.

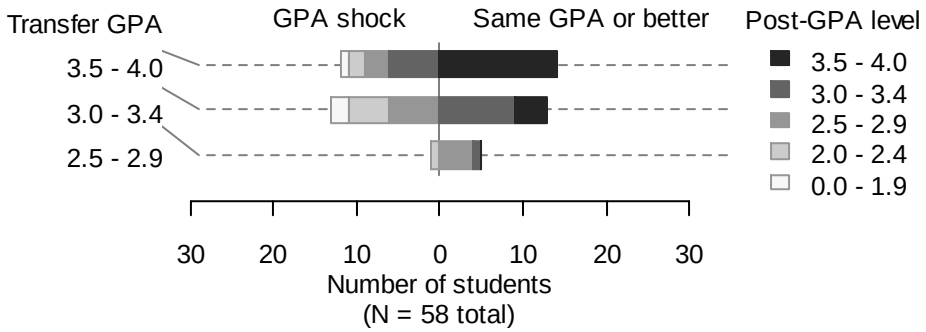

Figure 2. GPA shock for students transferring from 4-year institutions.

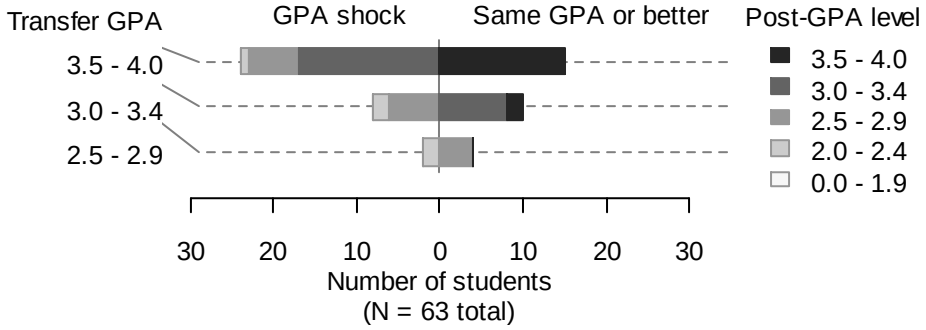

Figure 3. GPA shock for students transferring from 2-year institutions.

Discussion

Our paper aims to provide a descriptive overview of a sample of students participating in the larger-scale MIDFIELD study of engineering students at eleven four-year institutions. We sought to characterize the transfer patterns (vertical versus lateral) in a sample of undergraduate engineering students to determine if the relative dearth of literature on the lateral pathway compared to the often-studied vertical pathway was warranted. We also wanted to examine the presence of articulation agreements and dual degree programs, since these were originally created in an effort to ease the transition from one institution to another. A final goal of the paper was to investigate the academic outcomes of the sample of students, specifically looking for evidence of transfer shock and transfer ecstasy among these undergraduate engineering majors. This paper provides a critical foundation for our larger-scale qualitative study, which seeks to delve into the narratives of transfer students in engineering beyond just the academic transition at five of the eleven MIDFIELD institutions.

Regarding vertical versus lateral transfers, our study shows that almost half (46%) of the students in our sample transfer laterally from one four-year institution to another. While lateral transfer students do not make up a majority of the transfer students in our sample, our results indicate that

they are still underrepresented in the literature, as much of the literature on transfer students focuses on the transition from a community college to a university, or vertical transfer.[15,17] The large percentage of lateral transfer students in our sample demonstrates the need for more researchers to consider lateral as well as vertical transfer students, especially in light of the differences between the two pathways that prior studies have demonstrated.[13,14,15] We acknowledge that there are systemic influences on the prevalence of a particular pathway. State policies that encourage 2-year to 4-year transfers or common governance of all public higher education institutions would likely yield greater two- to four-year transfers. We only have a small sample of states represented here. However, lateral transfers are nearly forgotten in the literature. With more research on lateral transfers, we can better understand the various transfer pathways and help administrators and faculty members to better prepare transfer students depending on the path they choose. In doing so, we would hope to see retention and graduation rates among transfer students improve and time to degree completion rates decrease. Our qualitative analysis of the interview transcripts will explore this theme in more depth.

Further, Goldrick-Rab and Pfeffer's[17] research on lateral transfer students suggests that differences among lateral transfer students must be considered as well, especially socioeconomic differences. They found that lateral transfer students (who transfer from one four-year institution to another) generally transfer for personal reasons, such as wanting to attend a higher quality school. We heard this reason from some students in our interviews as well as other personal reasons, such as a desire to be closer to home or to be with a significant other. Further analysis of our qualitative interviews will explore this issue further by including questions about the influence of parental education and family preferences on selection of colleges. We are particularly interested in learning whether our respondents' reasons for engaging in vertical versus lateral transfer differ and whether one group tends to use the first school as a "stepping stone" more than another group.[19]

The presence of articulation agreements and dual degree programs is another factor to consider, as these arrangements were established to smooth the transition for students who transfer from one institution to another. All four schools included in the study have some sort of agreement with other institutions, and two of the MIDFIELD schools are located in states that participate in statewide agreements among public institutions in their respective states. Although a majority of transfer students in our sample stayed in the same state when they changed schools, three of the four schools in the present study have arrangements with schools in other states, giving transfer students a variety of options. Whether or not the agreements effectively ease the transition for transfer students is beyond the scope of the current study; however, both the large presence of arrangements and the fact that 72% of our respondents came from schools with some sort of agreement indicates that students are able to take advantage of them.

The preliminary analysis of our qualitative interviews suggests that those students attending schools with strong articulation agreements and a statewide course numbering system seemed to experience the least amount of problems transferring credits. Students in our interviews often cited the presence of these agreements as a reason for choosing their initial institution. Such arrangements provide students with ready-made pathways for planning the transfer process, with the resulting smoother transitions. Our future qualitative analysis will allow us to explore this relationship in more depth.

Finally, the students in our sample show moderate evidence of GPA shock. Fifty percent of those surveyed experienced a decline in their GPA using our broad measurement categories. However, many of the students in the sample remained in the same GPA bracket, demonstrating at least that their academic transition, as measured by GPA, was somewhat smooth. Additionally, only 6% reported transfer ecstasy, or an increase in GPA from the sending institution to the receiving institution. The small percentage of students who experienced transfer ecstasy may be an indicator of the difficulty of the engineering major. The GPA shock may also be a result of the lack of "shock absorbers" at the receiving institution since students are not generally allowed to transfer their GPA from their prior institution – only credits. Most students, therefore, who have completed their relatively easy general education requirements elsewhere, do not have the benefit of the higher grades in those courses to buffer their GPAs in the same way that native students would.[44]

Between the transfer pathway types, more vertical transfer students in our sample reported GPA shock than lateral transfers, but only by a slight margin. This finding is contrary to that of Kirk-Kuwaye and Kirk-Kuwaye,[15] who found that community college students adjusted better to a university setting than students who had transferred from other four-year schools, probably because the community college students were better forewarned to expect differences in the new setting. However, this finding supports Laanan's[45] research on the transfer student transitions. This may also reflect elements unique to the study of engineering, such as the difficulty of the upper level coursework, which has not been directly addressed in the literature, a theme that we will explore more fully when analyzing the interview transcripts.

Conclusion

Educators and policy makers have become increasingly concerned with broadening participation in STEM fields and increasing the quantity and quality of STEM baccalaureate degree recipients. The MIDFIELD study enhances our understanding of the current and potential contribution of transfer students to the existing pool of engineering graduates. The results reported here, which describe the initial descriptive characteristics of our qualitative study on engineering transfer students, suggest that research needs to expand beyond the "typical" vertical transfer pathway. A more thorough understanding of the differences among types of transfer students can influence administrators and policymakers to enact the most efficient and effective programs and services to improve the transfer experience and to enhance student retention and graduation rates.

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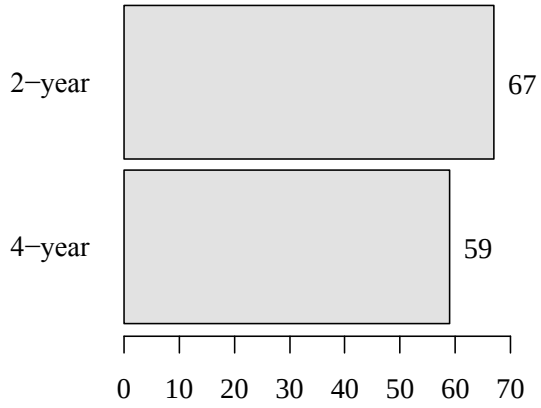
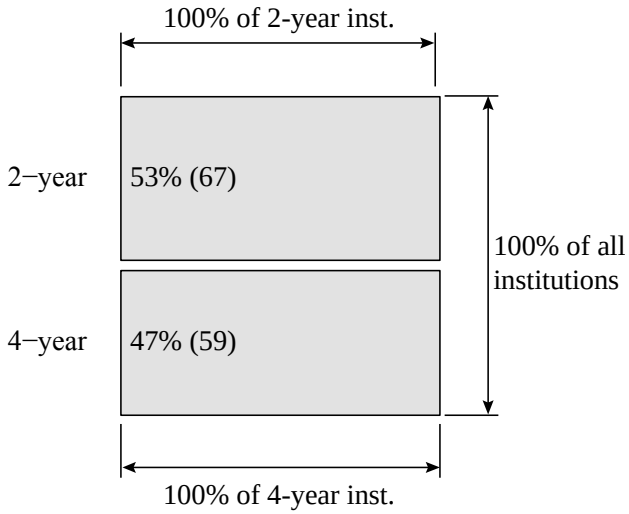
Appendix A

Tutorial on Mosaic Plots

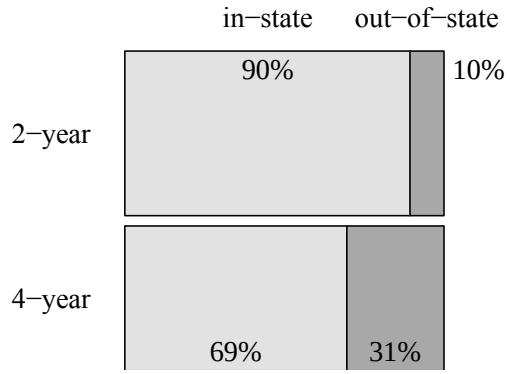
In a conventional bar chart, the horizontal bar lengths are proportional to the number of observations. The vertical bar heights are equal but arbitrary.



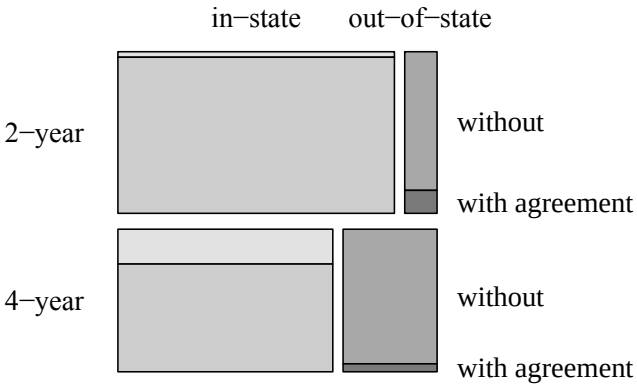
In a mosaic plot, the vertical bar heights are proportional to the number of observations. The bar height total is 100%. The horizontal bar lengths are equal and represent 100% of an observation type. The overall plot is square (100% in both directions). This graph shows one category (type of institution) with two levels (2-year and 4-year).



A new category (location) with two levels (in-state and out-of-state) is added by drawing vertical lines that proportionally subdivide each bar. The sum is still 100% in both directions. The shaded areas are the “tiles” in the “mosaic”.



A third category (agreement status) with two levels (with and without) is added by drawing horizontal lines that proportionally subdivide each tile.



In summary, mosaic displays "represent the counts in a contingency table by tiles whose size is proportional to the cell count." [46]

Appendix B

Number of Institutions with Which Study Institutions Have Formal Transfer Arrangements

Program Type	Institution 1	Institution 2	Institution 3	Institution 4
Onsite personnel at sending institution	**2**	**1**		
4 year in-state public HBCU	1			
4 year in-state public	1	1		
Distance ed classes to sending institution	**1**			
4 year in-state public	1			
Guaranteed admission from certain institutions if student meets minimum requirements	**20**	**24**		**38**
2 year in-state public	7	16		28
4 year in-state public	12	8		9
4 year in-state public HBCU	1			1
3+2 program	**33**		**17**	**3**
4 year in-state public	10		4	
4 year in-state public HBCU	2			
4 year in-state private HBCU	3		2	
4 year out-of-state private HBCU	3			3
4 year in-state private women's college/non-HBCU	1		1	
4 year out-of-state public HBCU	3			
4 year in-state private	7		7	
4 year out-of-state private	4		1	
4 year out-of-state public			2	
2+2 program	**2**			
2 year out-of-state public	2			
Transfer block		**26**	**16**	**28**
2 year in-state public		15	16	28
4 year in-state public		11		9
4 year in-state public/HBCU				1
Articulation agreement				**3**
4 year in-state private				3
Site visits to sending institution			**1**	**1**
2 year in-state public			1	1

Note: some institutions are duplicated when they have either multiple arrangements with one school or arrangements with multiple schools