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A Comparative Analysis of Support Perceptions between Transfer and First-Time-in-College Students in Engineering, Science, and Mathematics Programs

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Introduction

An important mechanism for retaining engineering students is offering support programs at the college level, which includes, for example, formal structures such as living-learning communities as well as both formal or informal opportunities for mentoring by faculty and peers. However, traditional student retention theories concentrate primarily on the institutional level [1]–[5]. The STEM Student Perspectives of Support Instrument (STEM-SPSI) was developed based on the Model of Co-Curricular Support (MCCS), a framework that refocuses the context to the college level. The STEM-SPSI assesses students' perceptions of the support provided by the college's academic, social, and professional systems [6], [7]. This paper utilizes the STEM-SPSI to investigate differences in support perceptions between transfer students and first-time-in-college students in engineering, science, and mathematics colleges. This comparison is another step towards building the validity of this instrument, understanding differences between subpopulations of students, and considering disciplinary differences in student support [8].

For the past three decades, institutions and researchers have mainly focused on first-time-in-college (FTIC) engineering students, with limited attention to the persistence of students who begin their educational paths at a different institution [9]. Although focusing on FTIC students is important, the higher education community must also prioritize understanding transfer students' unique experiences and paths to degree. Transfer students refer to students who attend multiple institutions while pursuing a bachelor's degree [10], [11], whether that be via a community college pathway (i.e., vertical transfer) or via another bachelor's granting institution (i.e. lateral transfer).

The purpose of this quantitative paper is to explore the differential perceptions of support between transfer and first-time-in-college (FTIC) undergraduate engineering students using the STEM-SPSI. The existing body of research on student support mostly focused on the effect of *specific intervention*s or student support resources, such as a program within the diversity support office [12]–[14]. However, this study seeks to make this comparison considering perceptions of different kinds of supports captured via 12 constructs identified in the STEM-SPSI. Rather than seeking to isolate specific interventions, this paper focuses on perceptions of different kinds of support across interventions. We also conduct similar analyses for students enrolled in colleges housing Science and Mathematics disciplines to determine the extent to which findings hold true across college-level contexts. The following research questions guide the objective of this study:

1- What are the differences between undergraduate engineering transfer students' and first-time-in-college students' perceptions of support?

2- What are the differences between undergraduate science and mathematics transfer students' and first-time-in-college students' perceptions of support?

Literature Review

Community colleges are an important starting point for engineering transfer students. These institutions provide a great service to students by offering them the opportunity to enter higher education at a fraction of the cost, thereby providing access to higher education for a diverse group of students. The AACC report highlighted more than 56 percent of students from minoritized groups often enroll in community colleges [15]. Further, the National Science Board and national surveys reported community colleges enroll a larger proportion of racially minoritized and economically disadvantaged students than four-year institutions [16]–[18]. These reports signified the role that community college can play in broadening participation in the field while also being a cost-effective pathway for pursuing higher education when it functions as it is designed to work. Hence, research on transfer students in the science, technology, engineering, and math (STEM) fields is aligned with policymakers' concerns about how to build a competitive, diverse workforce within engineering.

This paper was motivated by existing research suggesting that community college students often face difficulty successfully integrating into a four-year degree institution [19]. For example, Laanan [20] observed that community college students often feel at a loss during their first year in any four-year degree institution. Chen [21] discovered transfer student challenges in their adjustment resulting in their lower success rates in 4-year institutions. In addition, other studies suggest specific integration difficulties in STEM majors. Building out effective support mechanisms can work toward helping students overcome these difficulties [22]. Hence, there is a need for a holistic understanding of undergraduate transfer students' perceptions of support in STEM academic environments; identifying differences in transfer students' experiences in comparison to first-time-in-college students can offer specific areas in which colleges could focus their limited resources [5], [7], [23].

Student Perspectives of Support Instrument (STEM-SPSI)

Universities and academic institutions are becoming increasingly concerned about students' retention and students' feelings related to success on their campuses [24]. Support resources not only provide support for students inside their classes but also offer support outside of classes [25]. Such resources include, for example, student organizations and clubs, academic advising, tutoring, service projects, orientation activities, internships, co-ops, and other inside and outside the class activities [26], [27]. While several resources provide support for undergraduate students, there is a need to have a holistic approach to measure various types of support that are offered to students [5], [7], [23].

Support for undergraduate students is offered in various layers, including institutional and individual interventions. Lee and Matusovich [6] developed the model of co-curricular supports (MCCS) based on Tinto's [28] model of institutional departure and identified the various approaches that offer support for undergraduate students in STEM. Lee and Matusovich's MCCS framework consists of six foundational elements of support, including: 1- academic support, 2- peer-interaction support, 3- extra-curricular support, 4- faculty-interaction support, 5- professional development support, and 6- additional support. Using the MCCS conceptual model as its grounding, Lee et al. [29] developed an instrument, the STEM Student Perspectives of

Support Instrument(STEM-SPSI), to measure how STEM students perceive the existing support available to them within their colleges [29], [30]. Analyses of survey responses identified 12 factors of kinds of support, including: 1-academic advising support, 2- academic peer support, 3- faculty support, 4- STEM faculty connections, 5- student affairs support, 6- out-of-class engagement, 7- STEM peer connections, 8- graduate student connections, 9- STEM career development, 10- general career development, 11- cost-of-attendance support and planning, 12- diversity and inclusion. This paper explores the differential perceptions of support between undergraduate transfer students and FTIC students along these twelve constructs.

Method

A total of 1,377 undergraduate students from nine universities completed the STEM-SPSI instrument electronically. The institutions were mainly large, predominantly white, public land-grant universities—this intentional sampling focused on the kinds of institutions that educate the greatest number of engineers whereby it is particularly important to use instruments like the STEM-SPSI to monitor how individuals at high enrollment institutions perceive support. Data collection was conducted in the spring of 2019.

Sample demographics are similar to the respective college populations in terms of race and gender. The percentage of female participants in Science and Mathematics (44.9% female n = 192, 18.7% male n = 80) is slightly more than the female population in engineering (29.9% female n = 284, 35.7% male n = 339), also consistent with populations at these institutions given the more diverse life sciences with respect to gender. The self-reported demographics (race/ethnicity, gender identity, FTIC/ transfer student) are in Table 1. It is important to note that the first goal of this instrument was to collect undergraduate students' perceptions of support. Students responded to 72 questions related to the 12 constructs of support before responding to demographic items. Instrument designers intentionally placed the demographic items at the end of the instrument, and so the amount of missing data in gender and race/ethnicity variables is indicative of survey dropout before students reached these demographic questions; we include full responses to the items comprising the 12 constructs.

Table 1
Demographics

	Engineering (%)[2]	Science and Mathematics (%)[1]
Race/ethnicity		
American Indian or Alaska Native	0.6	0.2
Native Hawaiian/Pacific Islander	0.1	0.0
Black or African American	2.8	4.7
Latino/-a/-x/ or Hispanic	5.4	4.4
South Asian	3.5	3.3
East Asian	10.0	7.2
Southeast Asian	2.4	1.6
Middle Eastern/North African	1.3	2.1
White	41.1	41.6

Another race/ethnicity not listed	1.2	0.9
Gender identity		
Women	29.9	44.9
Men	35.7	18.7
Other	2.7	2.8
Group		
FTIC	88.2	86.4
Transfer Student	10.6	13.3
Total	(n=949) 100.0	(n=428) 100.0

Note:1- Science and Mathematics (%) is the percentage of undergraduate students in Science and Mathematics. 2- Engineering (%) is the percentage of engineering undergraduate students.

Measures

The STEM-SPSI instrument [30] is derived from the six elements of support theorized by Lee et al. [6]. The instrument development process took eleven steps over the course of two years, from fall 2017 to fall 2019. First, Lee and Matusovich analyzed students' responses to open-ended questions based on Tinto's model. Next, focus group data were collected from undergraduate students to identify missing experiences and support then used this feedback to develop a pool of potential questions addressing support facets.

The first pilot test of the new survey was conducted on three institutions with 973 participants in the Spring of 2018. The pilot test outcome allowed the researchers conduct an Exploratory Factor Analysis [31]. The first pilot test was followed by survey iteration and further interviews to refine items.

Lee et al. described this development process and built evidence of its validity. Our study is conducted using the data collected in the second round of development, as described in Lee et al. We focus on comparing responses from first-time-in-college and transfer students.

For the perceptions of support items, participants were asked to indicate their level of agreement with each item on a five-point Likert scale from 1- "Completely Disagree" to 5- "Completely agree." Table 2 displays the construct name, construct definition, number of items within each construct, and Cronbach alpha reliability score.

Table 2:

Twelve Factors Defining the Student Perceptions of Support Instrument based on Confirmatory Factor Analysis

Construct	Definition	N	Reliability
Academic Advising Support	Institutional support geared towards disseminating information related to improving academic performance or circumstances, providing access to resources that support academic performance, or monitoring academic performance or development.	3	0.83
Academic Peer Support	Institutional support geared towards improving or increasing interactions among students that contributed to their academic success.	4	0.78

Faculty Support	Institutional support geared towards establishing, improving, or increasing interactions among students and faculty/staff as it relates to their academic performance.	8	0.91
STEM Faculty Connections	Institutional support geared towards establishing, improving, or increasing interactions among students and STEM faculty/staff, increasing the quality of interactions students have with faculty/staff, and helping students establish relationships with faculty or staff related to professional development.	7	0.91
Student Affairs Support	Institutional support geared towards helping students navigate non-academic aspects of the student experience.	3	0.83
Out-of-Class Engagement	Institutional support geared towards improving or increasing extra-curricular immersion in both social and professional activities hosted on campus and around the local community.	8	0.89
STEM Peer Connections	Institutional support geared towards interactions among students in STEM majors, increasing the quantity of interactions that students have with other students outside of the classroom, or grouping students based on some part of their academic circumstances.	5	0.90
Graduate Student Connections	Institutional support geared toward students interacting with graduate students, developing mentoring relationships, or networks to promote learning and professional growth.	5	0.92
STEM Career Development	Institutional support geared towards career opportunities via an undergraduate degree in STEM, providing access to experiences and role models to prepare me for a career in STEM, or developing industry independent skills that contribute to successful professional performance.	10	0.90
General Career Development	Institutional support geared toward developing industry-independent skills that contribute to obtaining employment, or providing access to resources that contribute to the professional development of students along different career trajectories.	5	0.81
Cost of Attendance Support and Planning	Institutional support geared towards facilitating awareness and access to financial assistance needed to attend the university.	7	0.88
Diversity and Inclusion	Institutional support geared toward acclimating students into the university environment, or promoting diversity and inclusion in the form of resources as well as celebratory events.	5	0.86

Note: twelve factors of STEM-SPSI were defined and validated by Lee et al. [30].

Analysis

Based on undergraduate students' classification of themselves as first-time-in-college or transfer students, we compared students' responses to the 12 constructs between these two groups. Of the 949 engineering students, 837 (88.2%) identified as FTIC and 101 (10.6%) as transfer students. Of the 428 Science and Mathematics students, 370 (86.4%) identified as first-time-in-college and 57 (13.3%) identified as transfer students. The difference between the number of students in each comparison group suggested using a quantitative method that took into account comparisons of groups with unequal sample sizes.

To explore group mean differences between groups in two categories, we conducted Welch's t-tests using SPSS 28. Welch's t-test is a standard statistical test used to compare the means of two groups with unequal sample sizes and variances [32]. We also calculated the standardized Cohen's d effect size to show the practical significance of the average difference between two groups of students. According to Cohen, an effect size less than 0.2 is considered small, an effect size between 0.2 and 0.5 is considered medium, and an effect size from 0.5 to 0.8 is considered large [33].

Result

As previously stated, group comparisons were conducted to address the two research questions. The first question focused on comparing first-time-in-college (FTIC) and transfer students in the college of engineering. An independent-sample Welch's t-test was performed on a sample of 837 FTIC and 101 transfer students to determine if there was a difference in perception of support. The results of Welch's t-test revealed a significant difference in how student perceive their connection and interactions between transfer and FTIC students. Transfer students reported significantly lower perceptions of academic peer support (mean = 3.65, SD = 1.08) compared to FTIC students (mean = 3.90, SD = 0.90), t(98) = 2.023, $p < 0.05$, with a moderate effect size according to Cohen's d (d = 0.266). As shown in Table 3, there were no other constructs whereby FTIC and transfer students reported significantly different perceptions of support.

Table 3: Difference in Perceived Student Support Across FTIC and Transfer students in Engineering.

Student Support Construct	Mean Comparison Across FTIC and Transfer Students in Engineering				
	FTIC (M±SD)	Transfer (M±SD)	t-stat	Corrected p-value	Cohen's d
Academic Advising Support	3.91±0.90	3.85±0.93	0.639	0.524	
Academic Peer Support	3.90±0.90	3.65±1.08	2.023	0.046*	0.266
Faculty Support	3.82±0.76	3.75±0.87	0.729	0.468	
STEM Faculty Connections	2.72±1.12	2.93±1.31	-1.246	0.217	
STEM Peer Connections	4.05±0.96	3.75±1.19	1.97	0.052	
Graduate Student Connections	2.18±1.24	2.41±1.36	-1.253	0.214	
Out-Of-Class Engagement	3.63±0.87	3.45±1.05	1.383	0.171	
Student Affairs Support	3.44±1.10	3.29±1.19	0.88	0.382	
STEM Career Development	3.50±0.97	3.41±1.05	0.504	0.617	
General Career Development	2.41±1.11	2.74±1.32	-1.267	0.215	
Cost-Of-Attendance Support And Planning	2.94±1.05	3.06±1.13	-0.668	0.507	
Diversity And Inclusion	3.57±1.00	3.44±1.21	0.754	0.454	

*Note: All p-values are two-tailed. * significant at p-valued <0.05.*

The second research question examined the differing perceptions between first-time-in-college (FTIC) and transfer science and math students. The Welch test showed that FTIC students reported a significantly higher perception of STEM peer connections (mean = 3.69, SD = 1.01) compared to transfer students (mean = 2.84, SD = 1.16), t(49) = 4.432, $p < 0.001$. In addition, transfer students perceived a significantly lower perceptions of support via out-of-class engagement (mean = 2.87, SD = 0.94) compared to FTIC students (mean = 3.51, SD = 0.89), t(47) = 3.979, $p < 0.001$. Furthermore, transfer students' perception of support for general career development (mean = 1.98, SD = 0.91) was significantly lower than that of FTIC students (mean = 2.60, SD = 1.20), t(38) = 2.951, $p < 0.05$. Finally, transfer students' perception of support for diversity and inclusion was significantly lower (mean = 2.98, SD = 1.02) than FTIC students (mean = 3.47, SD = 1.05), $t(38) = 2.437$, $p < 0.05$, as depicted in Table 4.

Table 4: Difference in Perceived Student Support Across FTIC and Transfer students in Science and Mathematics.

Student Support Construct	Mean Comparison Across FTIC and Transfer Students in Science and Mathematics				
	FTIC (M±SD)	Transfer (M±SD)	t-stat	Corrected p-value	Cohen's d
Academic Advising Support	3.77±1.04	3.69±1.06	0.495	0.622	
Academic Peer Support	3.54±1.01	3.29±1.13	1.375	0.175	
Faculty Support	3.90±0.77	3.71±0.96	1.328	0.189	
STEM Faculty Connections	2.82±1.17	2.42±1.12	1.855	0.071	
STEM Peer Connections	3.69±1.01	2.84±1.16	4.432	<.001**	0.824
Graduate Student Connections	2.55±1.38	2.34±1.33	0.855	0.397	
Out-Of-Class Engagement	3.51±0.89	2.87±0.94	3.979	<.001**	0.719
Student Affairs Support	3.43±1.15	3.03±1.22	1.647	0.108	
STEM Career Development	3.04±1.09	2.76±0.86	1.226	0.231	
General Career Development	2.60±1.20	1.98±0.91	2.951	0.005*	0.538
Cost-Of-Attendance Support And Planning	2.71±1.14	2.46±0.97	1.208	0.234	
Diversity And Inclusion	3.47±1.05	2.98±1.02	2.437	0.02*	0.469

*Note: All p-values are two-tailed. * significant at p-valued <0.05, ** significant at p-valued <0.001.*

Discussion

One of the promising findings of our work is that there were not many differences between engineering FTIC and transfer students in terms of their perceptions of support. In this kind of analysis, we would hope to not see many differences by student pathway—rather, colleges seek to support all students along these dimensions. The one significant difference pertained to academic peer support, where transfer students in engineering reported feeling less supported than FTIC students. In contrast, science and math transfer students have less support than their FTIC colleagues in their interactions with other students and their involvement in class and out-of-class activities, including extra-curricular activities geared toward STEM. Findings also suggest that transfer students studying science and mathematics perceived less support with respect to career development resources and support around diversity and inclusion.

The lower perceptions of transfer students towards peer interaction are similar for both engineering and science/math groups, with engineering transfer students pointing to lacking connections in academic settings, whereas science and math students point to lacking connections with STEM peers generally and in out-of-class activities. Grant et al. [24] suggested that students with a stronger sense of peer support can better adjust to the educational environment, and it seems as if there is room for improvement in how colleges can help transfer students connect to other peers within their majors. This finding is similar to implications noted in prior research focused on engineering transfer students that called for colleges to help engineering transfer students connect to disciplinary peers as opposed to connecting transfer students to other transfer students without considering the discipline [34]–[36]. Notably, students' involvement in extra-curricular activities positively correlates with their perceptions of interaction with peers [37], and in the case of science and math, there is likely a positive feedback loop between the peer construct and the out-of-class activity construct.

We also noticed that there were a greater number of differences between transfer and FTIC students in science and math relative to engineering. This finding is good news for colleges of engineering and likely a sign of the efficacy of the support structures that have continued to grow in robustness within engineering. Transfer students in science and math perceived the lowest support for general career development (mean =1.98), which in contrast to engineering, which is a professional field. To better understand this difference, it is helpful to examine previous studies that have compared groups in various academic fields [38], [39]. Differences between colleges of engineering in comparison with colleges of science and mathematics are suggested by Biglan [40] using a taxonomy for these fields such as applied/pure, hard/soft, and life/non-life—effectively the nature of knowledge, culture of the disciplines, and academic environments all differ along these dimensions [34]. Knight et al. [41] discussed how structures and resources within engineering differ from pure science and math fields. Our research demonstrates that such differences between the fields could be experienced by students across a range of constructs of student supports, particularly with respect to how transfer students experience their educational environments. For example, student support structures focused on women, racially minoritized students, and other forms of diversity among students have become quite common within engineering. If similar initiatives are more placed as the university level to support other colleges (e.g., through initiatives such as first year experiences or through the general education curriculum), it is possible that transfer students may miss these entities that could be focused more on early-year students at the university level.

Limitation

The main limitation of this study relates to the participants, who were self-selected into the study. We did not collect data from all cohort years and departments, and therefore we are limited to the sample of respondents at one point in time. Second, the collected data were self-evaluation; some respondents might not respond, and others partially responded to the instrument, particularly with respect to the individual demographic questions at the end of the survey. Third, the data collected is one snapshot of students' perceptions of support. Longitudinal data collection would help a researcher be able to identify changes over time in students' perceptions of support; it is unclear the extent to which respondents are reporting with a recency bias or whether they are able to think back across all of their experiences in the past year, which is what the items asked. Finally, one key difference between FTICs and transfer students is that the transfer students have another institution with which they could anchor their perceptions of support. If they had an incredibly supportive community college experience, it is possible their responses would be lower because of that past experience (and vice versa). Such relative comparisons would not be the case for FTIC students.

Conclusion

This study explored differential perceptions of support between first-time-in-college and transfer students, specifically in engineering colleges and colleges containing science and mathematics disciplines. We found that transfer students perceive less support in their interactions with peers (in both college contexts) and engaging in extra-curricular activities (science and math only). We suggest that decision-makers in academic institutions should consider how they can help transfer students facilitate interactions with their peers who have been in the discipline previously, perhaps in addition to connecting transfer students with other transfer students. Creating an environment that promotes peer interaction and student engagement with these students who have already figured out the system could not only improve transfer students' social and academic adjustment but also could potentially enhance transfer students' retention and success.

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