

Exploring the Impact of a Supportive Scholarship Program on Engineering Transfer Students' Learning Strategies

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Abstract—Engineering transfer students experience diverse pathways and unique challenges on their way to earning a degree. Some of these challenges include phenomena like transfer shock and fewer opportunities to build community and receive support. In this work in progress, we explore differences in learning strategies between engineering transfer students and non transfer students with particular focus on transfer students who are part of an NSF-funded S-STEM program. The S-STEM program supports low income engineering transfer students from diverse backgrounds through co-curriculum cohort activities and peer and faculty mentoring with the goal of reducing the negative impact of transfer shock and improving their academic success and persistence. We analyze self-reported quantitative survey data from students in three upper division mechanical engineering courses, comparing the learning strategies of transfer students, S-STEM scholars, and non transfer students. Generally, non transfer students report better learning strategies than transfer students, and S-STEM scholars report better strategies in some areas of peer learning and effort regulation than other transfer students.

Index Terms—transfer students, learning strategies, peer learning, help-seeking, scholarship program

I. INTRODUCTION

There are numerous challenges for students who transfer from a two-year institution to a four-year institution that can negatively impact their academic success and persistence. These challenges vary from institutional barriers, such as a lack of matriculation agreements or changing from a semester to a quarter schedule, to disruptions in learning habits or environment, and differences in academic norms. For example,

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transfer shock, a common phenomenon that impacts transfer students right after they transition from a two-year to a four-year institution, has been shown to negatively impact academic persistence and success [1], [2]. One factor that contributes to transfer shock is a lack of personal relationships with faculty and a lack of social integration with peers [3]. This may be due to differences in academic norms between institutions and has been shown to negatively impact learning strategies, such as help seeking behavior [1]. There is little research on the learning strategies of engineering transfer students, but the importance of research in this direction and a qualitative analysis of engineering transfer students' learning goals and strategies are discussed in [4]. Understanding these students' learning strategies is important to know how to better support their success in engineering and reduce the attrition of engineering transfer students.

Related research focuses on learning strategies in fundamental engineering courses and the persistence of engineering majors in general. Fundamental courses are often the first that transfer students take when they start at the four-year institution and, therefore, provide an important opportunity to support students in adopting effective learning strategies and motivating them to persist in engineering. An example of a collaborative/peer learning strategy that positively impacted students' learning and attitudes towards engineering in a fundamental engineering course was proposed in [5], in which students worked in teams that particularly focused on problem identification and analysis. Engagement has been proposed as a precursor for persistence, and the importance of supportive programs for persistence of engineering majors and the need for more programs to attract engineering students is described in [6]. Moreover, learning strategies and quality interactions

with peers and faculty have been identified as “engagement indicators” in the National Survey of Student Engagement (NSSE) [7]. For STEM transfer students in particular, quality faculty and peer mentoring have been identified as a potential remedy for transfer shock and as a way to improve transfer students’ persistence and academic success [2], [8], [9]. Transfer students represent an important group for more migration into engineering, and better understanding their learning strategies and interactions with peers and faculty will help in designing programs that improve their engagement and persistence.

In this work in progress paper we explore the learning strategies of undergraduate engineering transfer students at the University of California Irvine (UCI) with special focus on students in an NSF-funded S-STEM program that we developed to support low income engineering transfer students from diverse backgrounds [10]. The program directly facilitates faculty and peer mentoring with the goal of reducing the negative impacts of transfer shock and improving students’ learning strategies, academic persistence, and success. Our research questions are:

- R1: What are the similarities and differences in learning strategies of transfer versus non transfer undergraduate engineering students?
- R2: What are the similarities and differences in learning strategies of transfer students who participate in the scholarship program versus other undergraduate engineering transfer students?

To answer these questions, we surveyed students in three upper division mechanical engineering courses over the previous two years, asking questions related to learning strategies such as management of time and study environment, peer learning, help-seeking, and effort regulation. We present demographic data of the students who completed the survey and results from a preliminary analysis of quantitative survey responses, including descriptive statistics and results from pairwise statistical tests comparing responses from different groups of students. Finally, we discuss future work and how this research will inform the implementation of the ongoing scholarship program with the goal of diversifying pathways into engineering.

II. DATA COLLECTION

The data for this study consist of self-reported quantitative survey data and institutional data from three different courses at UCI: ENGRMAE 106 Mechanical Systems Laboratory in Winter 2023, and ENGRMAE 151 Mechanical Engineering Design in Winter 2022 and Winter 2023. These courses are required upper division undergraduate mechanical engineering courses with lectures and significant hands-on learning experiences through team projects. All study participants were enrolled in the courses and participated voluntarily without compensation. The survey was administered online the week before final exams, which coincides with when students are completing their team projects in both of these courses.

We received student demographic data from the university’s teaching center, and all data were collected with approval from

the university’s Institutional Review Board. The numbers and demographics of students who were enrolled in the courses and who responded to the survey are reported in Table I. All the students in this data set were enrolled in only one of the courses, and none responded to the survey multiple times. 22 S-STEM scholars were enrolled in these courses out of a total of 99 S-STEM scholars who have participated in the program since Fall 2019.

TABLE I: Student demographics.

Group	Number of Students (and % of total in each category)	
	Enrolled	Respondents
Total	429 (100%)	393 (100%)
S-STEM	22 (5.1%)	22 (5.6%)
Low income	108 (25.2%)	101 (25.7%)
First Generation	165 (38.5%)	155 (39.4%)
Transfer	65 (15.2%)	63 (16.0%)
Female	76 (17.7%)	69 (17.6%)
URM ^a	135 (31.5%)	127 (32.3%)
Junior	10 (2.3%)	8 (2.0%)
Senior	419 (97.7%)	385 (98.0%)

^aUCI defines Underrepresented Minority (URM) students as those who identify as Black, Latino, American Indian, Pacific Islander, Chicano, or Filipino.

A. Survey Questions

We employ survey questions from the Motivated Strategies for Learning Questionnaire (MSLQ) [11]. The MSLQ is a comprehensive and widely used survey instrument that has been used and validated in engineering education [12]. In this work, we analyze responses to the 19 survey questions that ask about learning strategy constructs related to time and study environment, peer learning, help-seeking, and effort regulation. Responses to these questions are reported on an anchored numeric scale from 1 to 7 where 1 = ‘Not at all true of me’ and 7 = ‘Very True of me’. The survey questions are:

Time and study environment:

- Q1: I usually study in a place where I can concentrate on my course work.
- Q2: I make good use of my study time for this course.
- Q3: I find it hard to stick to a study schedule.
- Q4: I have a regular place set aside for studying.
- Q5: I make sure I keep up with the weekly readings and assignments for this course.
- Q6: I attend class regularly.
- Q7: I often find that I don’t spend very much time on this course because of other activities.
- Q8: I rarely find time to review my notes or readings before an exam.

Peer learning:

- Q9: When studying for this course, I often try to explain the material to a classmate or a friend.
- Q10: I try to work with other students from this class to complete the course assignments.
- Q11: When studying for this course, I often set aside time to discuss the course material with a group of students from the class.

Help-seeking:

- Q12: Even if I have trouble learning the material in this class, I try to do the work on my own, without help from anyone.
- Q13: I ask the instructor to clarify concepts I don’t understand well.
- Q14: When I can’t understand the material in this course, I ask another student in this class for help.

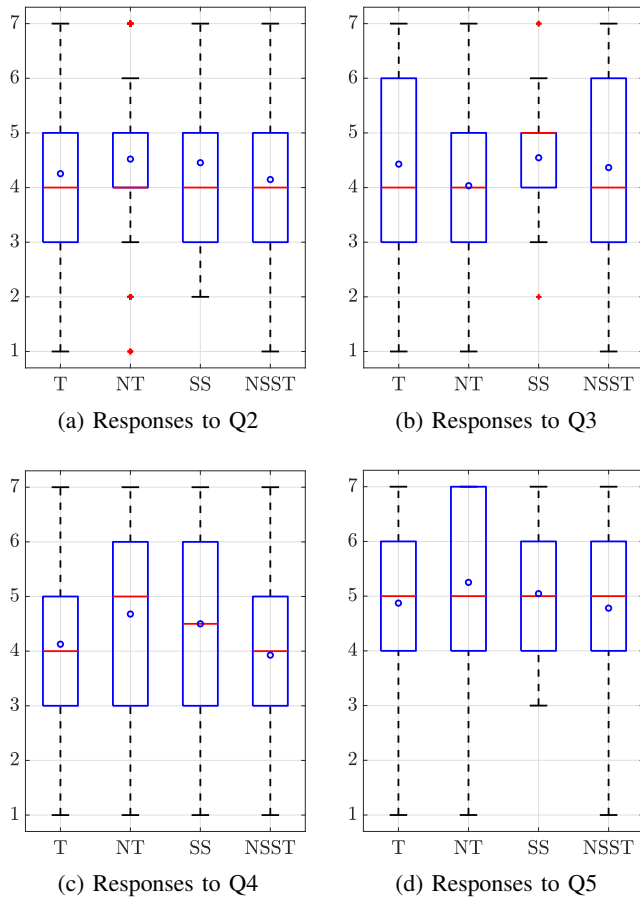


Fig. 1: Survey responses to Q2-Q5 related to time and study environment from all four groups considered: Transfer (T), Non Transfer (NT), S-STEM (SS), and Non S-STEM Transfer (NSST). 1 = ‘Not at all true of me.’ 7 = ‘Very true of me.’ The red line indicates the median, the blue circle indicates the mean, the top and bottom edges of the box indicate the 25th and 75th percentiles, and the whiskers extend to data points not considered to be outliers. Outliers are plotted as red +’s.

Q15: I try to identify students in this class whom I can ask for help if necessary.

Effort regulation

Q16: I often feel so lazy or bored when I study for this class that I quit before I finish what I planned to do.

Q17: I work hard to do well in this class even if I don’t like what we are doing.

Q18: When course work is difficult, I give up or only study the easy parts.

Q19: Even when course materials are dull and uninteresting, I manage to keep working until I finish.

III. METHODS AND PRELIMINARY RESULTS

We perform single item analyses and present descriptive statistics of the students’ survey responses and pairwise comparisons of responses from four different groups: 1) transfer students, 2) non transfer students, 3) students in the S-STEM program (S-STEM scholars), and 4) transfer students who are not in the S-STEM program. Descriptive statistics for

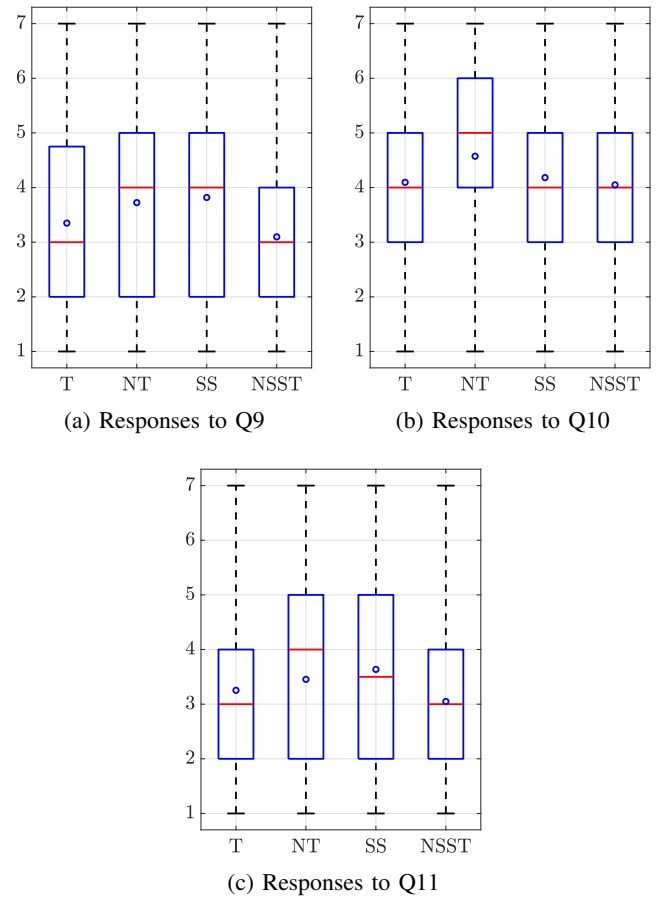


Fig. 2: Survey responses to Q9-Q11 related to peer learning. 1 = ‘Not at all true of me.’ 7 = ‘Very true of me.’

13 of the 19 survey questions are presented as box plots in Figures 1–4; responses to the remaining 6 survey questions had similar statistics across all four groups and are not shown. We perform Kruskal-Wallis nonparametric tests to pairwise compare responses from these different groups. Generally, non transfer students and S-STEM students more often report better learning strategies. Next we discuss the results in the context of research questions R1 and R2.

Regarding research question R1, the most significant differences between transfer students and non transfer students appear in their responses to the management of time and study environment and peer learning questions. Transfer students report more varying responses with respect to making good use of their study time (Fig. 1a, $p = 0.111$) and more frequently report finding it hard to stick to a study schedule (Fig. 1b $p = 0.105$). Additionally, non transfer students more frequently report having a regular place for studying (Fig. 1c, $p = 0.018$) and keeping up with weekly readings and assignments (Fig. 1d, $p = 0.088$). Regarding peer learning, non transfer students more frequently report trying to explain course material to a classmate or friend (Fig. 2a, $p = 0.077$) and working with other students in class (Fig. 2b, $p = 0.034$).

Regarding research question R2, the most significant dif-

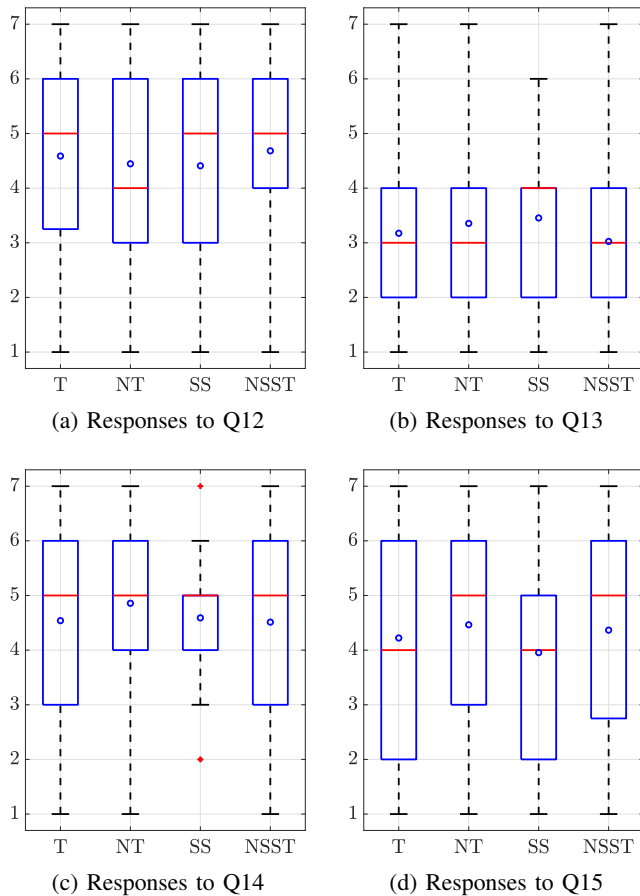


Fig. 3: Survey responses to Q12-Q15 related to help-seeking. 1 = 'Not at all true of me.' 7 = 'Very true of me.'

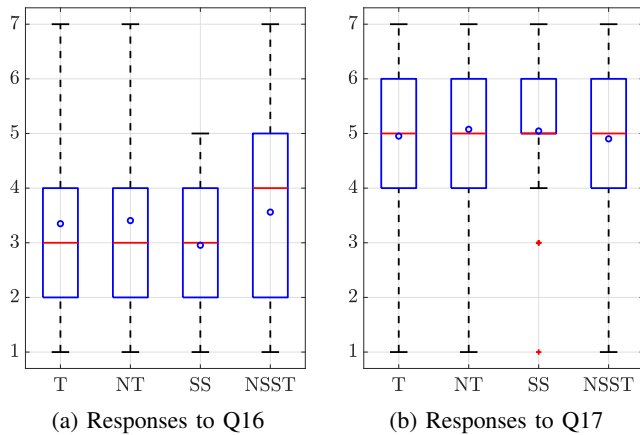


Fig. 4: Survey responses to Q16-Q17 related to effort regulation. 1 = 'Not at all true of me.' 7 = 'Very true of me.'

ferences between S-STEM scholars and transfer students who are not in the program appear in their responses to the peer learning and effort regulation questions. S-STEM scholars more frequently report trying to explain course material to a friend (Fig. 2a, $p = 0.117$) and setting aside time to discuss

course material with classmates (Fig. 2c, $p = 0.191$). S-STEM scholars less frequently report feeling lazy or bored when studying (Fig. 4a, $p = 0.119$). S-STEM scholars report less varying responses regarding asking other students in class for help (Fig. 3c) and regarding working hard to do well in the course (Fig. 4b).

Regardless of whether they are in the S-STEM program or not, transfer students report similar responses to making good use of study time (Fig. 1a), keeping up with weekly readings and assignments (Fig. 1d), and trying to work with other students from class to complete assignments (Fig. 2b).

IV. DISCUSSION AND FUTURE WORK

The results show that non transfer students and S-STEM scholars more frequently report employing effective learning strategies than transfer students in general, and non S-STEM transfer students in particular. This may be an indication that the supportive S-STEM program has a positive impact on engineering transfer students' learning strategies, which could be due to multiple reasons. For example, because the S-STEM program provides a scholarship, S-STEM scholars may be less stressed about their finances and may have more time to focus on learning rather than working a job. The S-STEM scholars also interact with peer and faculty mentors, which may increase their quality interactions with peers and faculty, broaden their support networks, and improve their confidence and ability in collaborative learning and asking for help.

There are a few limitations of this preliminary study. Only 22 of the total 99 S-STEM scholars are participants in this data set, and almost all of the participants are mechanical or aerospace engineering majors. Further work should be done to study the learning strategies of students in other engineering majors. This study also only included (mostly) senior students in two different courses during two Winter terms. It would be interesting to perform a longitudinal study that investigates how students' learning strategies change from immediately after they transfer until graduation to examine whether there are greater or faster improvements in learning strategies for transfer students who are in the S-STEM program versus those who are not. Furthermore, the first S-STEM cohort started in Fall 2019 before the COVID-19 pandemic; our data collection took place in Winter 2022 and 2023 when classes had multiple learning formats (e.g., remote, in person, and hybrid), which may have also impacted transfer students' learning strategies.

In future work, we will perform measurement invariance and factor analyses to extend this single item analysis to more completely compare students' learning behaviors. We will also explore whether responses to these questions are correlated with other factors, such as perceptions of self efficacy and test anxiety, number of units enrolled, time to degree, and GPA, among others. Moreover, we are also interviewing S-STEM scholars about their faculty and peer mentoring experiences as part of the program [13], and future work will involve analyzing both quantitative and qualitative data to better understand how to promote effective learning strategies for transfer students and to support their success in engineering.

REFERENCES

- [1] D. C. Elliott and J. M. Lakin, "Unparallel pathways: Exploring how divergent academic norms contribute to the transfer shock of STEM students," *Community College Journal of Research and Practice*, vol. 45, no. 11, pp. 802–815, 2021.
- [2] N. L. Smith and E. M. Van Aken, "Systematic literature review of persistence of engineering transfer students," *Journal of Engineering Education*, vol. 109, no. 4, pp. 865–883, 2020.
- [3] A. Monroe, "Non-traditional transfer student attrition," *The Community College Enterprise*, vol. 12, no. 2, pp. 33–54, 2006.
- [4] N. C. Van Tyne, L. D. McNair, and D. Reeping, "Meaning to succeed: Learning strategies of first-year engineering transfer students," in *ASEE Virtual Annual Conference*, 2021.
- [5] S. Huang and E. Pierce, "The impact of a peer learning strategy on student academic performance in a fundamental engineering course," in *2015 IEEE Frontiers in Education Conference (FIE)*, pp. 1–4, IEEE, 2015.
- [6] M. W. Ohland, S. D. Sheppard, G. Lichtenstein, O. Eris, D. Chachra, and R. A. Layton, "Persistence, engagement, and migration in engineering programs," *Journal of Engineering Education*, vol. 97, no. 3, pp. 259–278, 2008.
- [7] "National survey of student engagement (NSSE): Engagement indicators." <https://nsse.indiana.edu/nsse/survey-instruments/engagement-indicators.html>. Accessed: 2023-05-12.
- [8] T. V. Dinh and Y. L. Zhang, "Engagement in high-impact practices and its influence on community college transfers' STEM degree attainment," *Community College Journal of Research and Practice*, vol. 45, no. 11, pp. 834–849, 2021.
- [9] E. R. Winterer, J. E. Froyd, M. Borrego, J. P. Martin, and M. Foster, "Factors influencing the academic success of Latinx students matriculating at 2-year and transferring to 4-year US institutions - implications for STEM majors: a systematic review of the literature," *International Journal of STEM Education*, vol. 7, pp. 1–23, 2020.
- [10] A.-L. Dicke, K. Denaro, A. E. Rao, D. A. Copp, H. R. Lee, G. Diggs-Yang, and L. Valdevit, "Supporting low-income engineering transfer students' transition from community college to a 4-year university through a comprehensive scholarship program," in *ASEE Annual Conference & Exposition*, 2023.
- [11] P. R. Pintrich, D. A. F. Smith, T. Garcia, and W. J. McKeachie, "A manual for the use of the Motivated Strategies for Learning Questionnaire (MSLQ)," tech. rep., The University of Michigan, 1991.
- [12] O. Adesope, N. Hunsu, B. van Wie, B. Austin, R. Richards, and P. Dutta, "Work in progress: Assessing engineering students' motivation and learning strategies-a psychometric analysis of the motivated strategies for learning questionnaire," in *ASEE Annual Conference & Exposition*, pp. 1–6, 2017.
- [13] A.-L. Dicke, D. A. Copp, D. Nikkhah, K. Denaro, H. R. Lee, and L. Valdevit, "Work in progress: Exploring the use of faculty and peer mentoring as a tool to support engineering transfer students' transition," in *ASEE Annual Conference & Exposition*, 2023.