Relative Performance of Transfer vs. First-Time Freshmen at a Maritime College

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Abstract

Instructors of senior level classes in a mechanical engineering program noticed a difference in performance between students who had started as first-time freshmen and those who had transferred to the college and sought to investigate further. The college has recently increased the number of admitted transfer students, so the disparate performance is an increasing concern. As a confounding factor, the mechanical engineering program has an option for students to obtain U.S. Coast Guard licensure to work as a maritime engine watch officer. The transfer students overwhelmingly choose not to join the license program. It is possible that the noticed difference in performance is due to additional training in the license program that could be better incorporated in the other classes. In order to assess the impact of student status on program learning outcomes, the investigators examined grades in lower division courses and relative performance in required senior courses. Data were analyzed to assess whether there is a significant difference in learning outcome performance on complex engineering problems based on when students were admitted (first-time freshmen or transfer) and what option they selected (license or non-license). The results indicated that first-time freshmen performed significantly better than transfer students, but no statistically significant difference was identified between students pursuing a license compared to those who did not.

Introduction

The unique struggles of transfer students have been well-documented in the literature, so much so that Hills coined the term “transfer shock” to describe the common phenomena of a drop in GPA among students after transferring [1]. Specifically, this phenomenon has been found to be most acute in STEM majors transferring from two-year institutions [2], and it has been found to impact student performance in core major courses. Shayevich *et al.* examined grades in several junior level electrical engineering courses and found that first-time freshmen performed better than transfer students, and additionally, that this trend persisted across multiple instructors and semesters of the same course [5]. A number of possible causes for this have been examined; Laanan *et al.* found in a survey of transfer students that many felt less comfortable interacting with faculty at their new institution, and some felt increased stress and received lower grades [3]. Concannon and Barrow found that engineering transfer students have lower self-efficacy than first-time freshman, which was theorized to be due to transfer shock [4].

A systematic literature review [6] was unable to locate research on transfer students after their first post-transfer year, although the same researchers recently performed their own study to examine this question and found that transfer students, on average, experienced their lowest GPA in their second post-transfer semester, and that the GPA reduction persisted through at least the third semester post-transfer, which suggests that this phenomenon may affect later academic performance. The reasons for this are yet unclear, although students may have difficulty acclimating to the new learning environment or differences in academic standards between the previous and new institutions [7].

At SUNY Maritime College, the challenges facing transfer students can be exceptionally strong. The institution prides itself on having a rich maritime tradition and *espirit de corps*. It encourages these feelings within the student body starting freshman year; however, this means

that the transfer students at this institution can feel isolated on campus. Past studies have shown that a number of engineering transfer students name a lack of sense of belonging at their new institution as an obstacle to their academic performance [8] and that a sense of community strongly correlates with GPA in transfer students in STEM majors [9].

To accentuate these issues at SUNY Maritime College, there are two major cohorts of students: engine license and non-license students. Engine license option students pursue a U.S. Coast Guard Third Assistant Engineer, Unlimited license to operate the engine room of a commercial shipping vessel, while non-license students seek a more traditional college experience with 6 credits of internships over the summer. The students seeking a license must complete an additional 42 credits during their academic career, including 18 credits of summer practical work on a ship. This means the license students must take 17 to 19 credits every semester to graduate on-time. Therefore, students who transfer into the school tend not to select the license program and there is strong overlap between transfer students and non-license students.

This paper aims to assess whether transfer (XFER) students at SUNY Maritime College perform poorly in senior-level courses, long after the post-transfer semesters, compared to first-time freshmen (FTF). Performance scores were evaluated for three discipline-specific fourth-year courses, specifically looking for differences between FTF and XFER students, as well as license and non-license students. Based on the literature review and anecdotal evidence at the institution, it was expected that non-license, transfer students would have lower performance scores, which would prompt a review of potential interventions in the future, such as encouraging the traditions of the school for transfer students and buoying their sense of belonging.

Methods

Fourth year students in the Mechanical Engineering program are expected to take three discipline-specific courses: Vibrations, Computer Aided Engineering, and Mechanical Engineering Design I. These courses rely heavily on applying new analysis methods to previous coursework. Specific to this study, the instructors for these courses targeted two specific skill sets: problem setup and problem execution. These skills mirror the components of ABET student learning outcome 1, which says that students should develop “an ability to identify, formulate, and solve complex engineering problems” [10]. Setting up a problem requires students to appropriately identify what needs to be calculated from their existing engineering knowledge and formulate a process by which it can be solved. Problem execution follows on from this to finish any formulation and then solve the final problem. Each instructor provided at least one task that would assess the students’ abilities to perform these two skills separately. In-class examinations were used for the Vibrations and Mechanical Design courses, while homework assignments were used in Computer Aided Engineering. The data from each course was reported on a 0 to 4 scale corresponding to letter grade breakdowns. A 0 corresponded to an F (unsatisfactory work) and a 4 corresponded to an A (exceptional work).

In the given semester, there were 62 unique senior Mechanical Engineering students enrolled in the three courses, 37 of which were enrolled in all three courses. In total, there were 37 FTF students and 25 XFER students considered in this study. The breakdown of the number of FTF

and XFER students and degree options may be seen in Table 1. As seen in this table, the numbers of FTF students were more balanced across the two different degree options than XFER students, with the latter cohort having many more non-license students than license students.

Table 1: Number of students considered in the study by student type (FTF or XFER) and degree option.

	Student Type	
Degree Option	*FTF*	*XFER*
License	17	4
Non-License	21	20

Statistical Analysis

A repeated-measures analysis of variance (ANOVA) [11] was conducted in R [12] to evaluate the effects of Student Type (FTF or XFER), Degree Option (License or Non-license), and Question Type (Setup or Execution), as well as the interactions between these factors, on the performance scores. Since performances from three different courses were selected as part of the evaluation, a factor for Course was also included in the analysis. Statistical significance was considered for p-values below 5%. If a factor was determined to be significant, post-hoc pairwise comparisons were drawn using Tukey-Kramer adjusted p-values.

Results

The performance scores of the students were compared with a repeated-measures ANOVA, which indicated that the main effects of Course and Student Type were statistically significant with $p < 0.05$. None of the other factors, including the interaction effects between all of the factors respectively, were significant. Since each of the three different courses had different learning objectives and were taught by different instructors, it was not surprising that there were differences in the performance scores of the students. The lack of significance of the interactions between Course and other factors shows that the differences between the student types and degree options were consistent across all three courses.

There was a significant difference in performance between FTF and XFER students. A post-hoc pairwise comparison revealed that XFER students had poorer performance scores than the FTF students (see Figure 1). The performance scores for the XFER and FTF students were 1.7 ± 0.2 and 2.6 ± 0.1, respectively, with error reported as standard error (s.e.) of the means. Once again, there were no significant interaction factors in the analysis. Therefore, the differences between XFER and FTF students were consistent across Degree Option and Question Type.

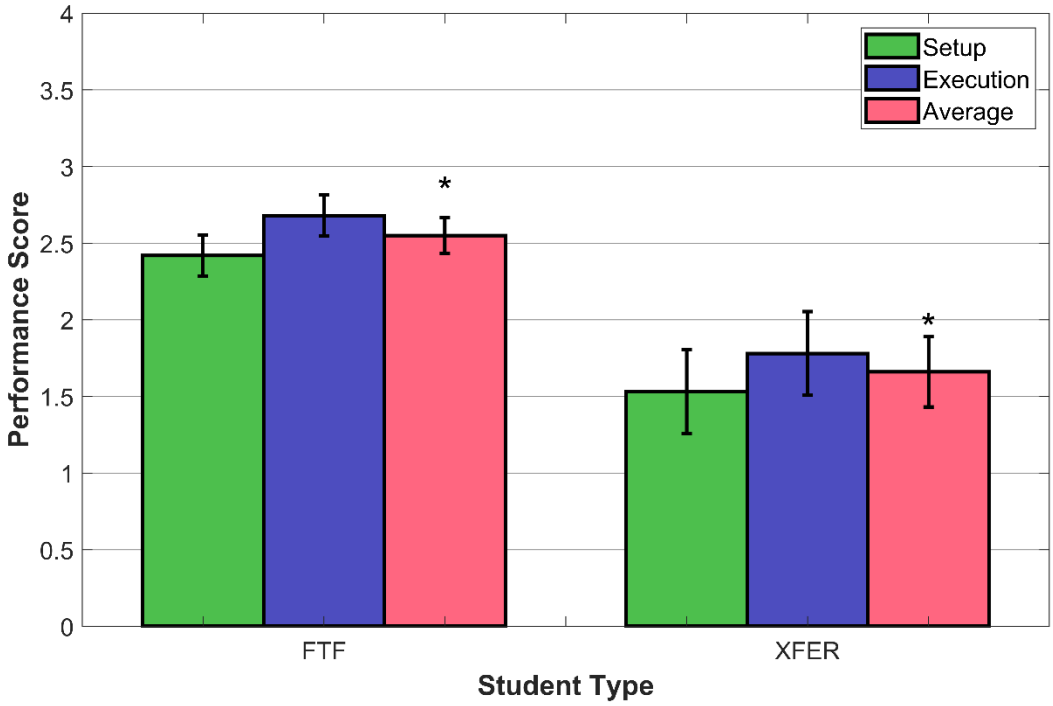

Figure 1: Performance scores of FTF and XFER broken down by Question Types. There were no significant differences between the types of questions for either group of students, but on average, the FTF students had higher performance scores than the XFER students, ($p < 0.002$, indicated by *). Error bars are reported as standard errors of the means.

The difference in performance for license and non-license students within the FTF and XFER student cohorts were not statistically significant (see Figure 2). Follow-on studies will continue to collect additional data to see if a statistically significant difference can be seen.

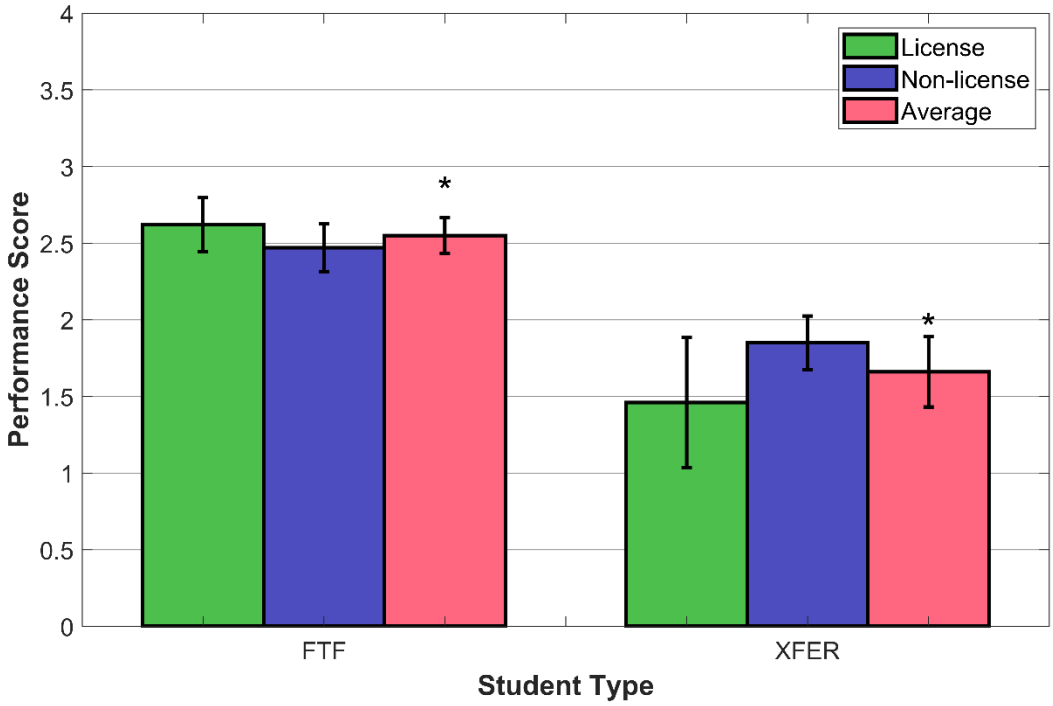

Figure 2: Performance scores of FTF and XFER broken down by Option Types. There were no significant differences between the options for either group of students, but on average, the FTF students had higher performance scores than the XFER students, ($p < 0.002$, indicated by *). Error bars are reported as standard errors of the means.

One initial limitation of the study was the population size of transfer students. Originally, only students enrolled in all three courses were considered. However, in reviewing the populations of the three classes, the XFER students were less likely to be enrolled in all three classes than the FTF students. Of the 25 unique transfer students in the courses, only 7 (28%) were enrolled in all three. By comparison, of the 37 unique first-time freshmen in the Mechanical Engineering program, 30 (81.1%) were enrolled in all three. As these three courses are only offered once per academic year, this indicates that the transfer students are significantly less likely to graduate on time.

An initial analysis shows academic performance to be a likely culprit in XFER students not being posed to graduate on time. The mechanical engineering curriculum has a junior-level course on the design of machine elements, such as shafts, bearings, and gears. This course is a prerequisite for the senior-level design course and is a common pitfall for students who struggle academically. As such, it can be used as a proxy for academic performance. Table 2 shows the percentages of students in the study who failed or had not yet received credit for the junior level design course. These percentages indicate that the transfer students struggle more academically, in that 20.8% of the XFER students considered in this study are not on track to graduate in time compared to only 5.3% of the FTF students. However, additional data is needed to properly quantify this performance.

Table 2: Percentages of students who were not successful in progressing through the junior-level design course on the first attempt

	Student Type		
Degree Option	*FTF*	*XFER*	*Combined*
License	2/17 (11.8%)	1/4 (25%)	*3/21 (14.3%)*
Non-License	0/21 (0%)	4/20 (20%)	*4/41 (9.8%)*
Combined	*2/38 (5.3%)*	*5/24 (20.8%)*	***7/62 (11.3%)***

It is also interesting to note the differences between license and non-license students who are not on track to graduate in time. While a gap between the license students and non-license students would be expected due to the additional credit loads for the license students, the large percentage differences between the non-license students who were admitted as freshmen compared to the ones who transferred is concerning. This discrepancy indicates that the transfer students may be more at risk of underperforming in higher-level classes than FTF license students who take over 16 credits most semesters, but further study is necessary.

Future work will focus on collecting more data within the same parameters to increase the sample sizes. Certain comparisons are limited due to the small populations, such as the transfer students who are in the license program. There were also certain students who were not in all three classes simultaneously. Collecting data over multiple semesters will allow these students to be analyzed. Additionally, the reviewers will attempt to increase the breadth of this study by incorporating results from a pre-requisite course that must be taken in Junior year. Pending the results, targeted interventions for students may be warranted based on their specific needs.

Conclusion

The results of the analysis indicate that regardless of degree option (license or non-license) XFER students performed worse than FTF students in three senior-level courses taught by different instructors. Looking more broadly, FTF students were also significantly more likely to be taking those three courses concurrently, as recommended in the degree curricula, indicating that they are more likely to be graduating "on-time." Additionally, a greater percentage of XFER students failed a key pre-requisite course on the first attempt. Although FTF are more likely to be license option students, the differences between license and non-license students were negligible within both the populations, which seems to indicate that the performance difference is due solely to transfer status.

The incidental finding regarding satisfactory academic progress in the major will need to be addressed at an institutional level. Students who transfer into the college appear to be more likely to be unable progress through the curriculum as intended and more likely to fail a fundamental mechanics course. Transferring into the institution appears to be a greater academic hurtle than taking a credit overload every semester.

References

[1] J. R. Hills, "Transfer Shock: the Academic Performance of the Junior College Transfer," *The Journal of Experimental Education*, vol. 33, no. 3, pp. 201-215, 2965.

[2] J. M. Lakin and D. C. Elliott, "STEMing the Shock: Examining Transfer Shock and Its Impact on STEM Major and Enrollment Persistence," *Journal of the First-Year Experience & Students in Transition*, vol. 28, no. 2, pp. 9-31, 2016.

[3] F. S. Laanan, D. L. Jackson and D. T. Rover, "Engineering transfer students: characteristics, experiences, and student outcomes," in *2011 ASEE Annual Conference & Exposition*, Vancouver, British Columbia, 2011.

[4] J. P. Concannon and L. H. Barrow, "A Cross-Sectional Study of Engineering Students' Self-Efficacy by Gender, Ethnicity, Year, and Transfer Status," *Journal of Science Education and Technology*, vol. 18, no. 2, pp. 163-172, 2009.

[5] A. Shayevich, J. Goldberg and J. Edson, "Performance and retention of transfer engineering students," in *2008 ASEE Annual Conference & Exposition*, Pittsburgh, Pennsylvania, 2008.

[6] 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.

[7] N. L. Smith, J. R. Grohs and E. M. Van Aken, "Comparison of transfer shock and graduation rates across engineering transfer student populations," *Journal of Engineering Education*, vol. 111, no. 1, pp. 65-81, 2022.

[8] M. E. Darrow, "Engineering transfer student leavers: voices from the sidelines of the engineering playing field," Ph.D. Dissertation, Iowa State University, Ames, Iowa, 2012.

[9] G. Townley, J. Katz, A. Wandersman, B. Skiles, M. J. Schillaci, B. E. Timmerman and T. A. Mousseau, "Exploring the role of sense of community in the undergraduate transfer student experience," *Journal of Community Psychology*, vol. 41, no. 3, pp. 277-290, 2013.

[10] ABET, "Criteria for Accrediting Engineering Programs, 2022 – 2023," 2022. [Online]. Available: https://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-programs-2022-2023/. [Accessed 12 February 2023].

[11] M. H. Kutner, C. J. Nachtsheim, J. Neter and W. Li, Applied Linear Statistical Models, Boston: McGraw-Hill Irwin, 2005, pp. 641-1208.

[12] R Core Team, *R: A Language and Environment for Statistical Computing*, Vienna, Austria: R Foundation for Statistical Computing, 2022.