

Examining the Academic Success and Transition Experiences of Engineering Transfer Students: A Comparative Analysis of ETS-IMPRESS and Traditional Engineering Pathways

Sarah (Yin Yin) Tan, Song-Lin Yang, David M. Labyak
Michigan Technological University

Abstract

Academic and career success hinges on diverse factors including students' perception of school readiness and expectation. Previous studies have indicated that transfer students transitioning from a 2-year college to a 4-year university in engineering programs, specifically those participating in S-STEM Engineering Technology Scholars (ETS) program, may face challenges in academic and career advancement. These challenges often stemmed from feelings of unpreparedness, lower self-efficacy, and a reduced feeling of inclusion, compared to their peers in the same honors program. However, little research has integrated both objective and subjective approaches, to assess and compare academic success between transfer students in the ETS program and their traditional engineering transfer counterparts.

This study focuses on examining whether participation in the Engineering Technology Scholars – IMProving Retention and Student Success (ETS-IMPRESS) program, designed to support underrepresented students in engineering technology (ET) fields, positively impacts the academic performance, retention, and time to graduation of ETS transfer students as compared to those following the traditional engineering transfer pathway. The study encompasses all transfer students, regardless of ETS enrollment, in the objective assessment with a total of 481 participants, including 12 ETS transfer students in ET majors, and 469 traditional engineering transfer students.

Objective measures and results, including GPA, retention rate and time to graduation, were sourced from institutional research on campus to evaluate student academic success. The student t-tests were employed for annual data analysis. Additionally, a subset of students (n=4 ETS, n=52 traditional) completed a survey in May 2023, consisting of four questions related to their preparedness, subjects they felt most and least prepared in, and their 2-year college experiences following their transition to a 4-year university. The first question employed a 5-point Likert preparedness scale while the remaining questions were open-ended. Student t-tests were utilized to compare ETS transfer students with their traditional engineering transfer peers, shedding light on student preparedness.

The objective analysis found no significant GPA differences ($P > 0.05$, for each year since 2018), signifying consistent academic performance among ETS transfer students. Despite varying retention rates, ETS students exhibited dedication and faster graduation. Subjectively, ETS students felt somewhat unprepared, but there is a trend towards similarity in preparedness ($P = 0.065$). Both groups valued math and engineering courses while considering social science

and humanities less preparatory. ETS students emphasized hands-on experiences and specialized coursework. Non-academic factors like dormitory living, time management, internships, and leadership programs aided readiness.

In the future, we will continue harnessing the programs and services offered by ETS, including research mentors, career service, mental service, community building activities, and honors programs, to enhance student academic performance and mental well-being. More conclusive insights will require time as our program expands and engages more scholars. As for future study, we plan to delve into the transition of our students into the workforce and their subsequent career outcomes and make a comparison with those following traditional engineering transfer pathways.

1. Introduction

Success in academics and career is shaped by a multitude of factors, among which students' perceptions of their preparedness for school and their expectations play significant roles [1], [2]. Previous research has indicated that transfer students in the S-STEM Engineering Technology Scholars (ETS) program, transitioning from a 2-year college to a 4-year university and majoring in hands-on ET disciplines, may encounter challenges in their academic and career progression (Fiss, et al., 2022) [3]. These challenges may stem from a perceived lack of preparedness, lower self-efficacy, and reduced feelings of inclusion when compared to their counterparts who followed the traditional path into the same Honors program [3], [4]. Various studies have explored key elements contributing to transfer students' academic success, such as GPA, credit accumulation, academic expectations, sense of belonging, and adaptability to new campus cultures [5-9].

Furthermore, ET programs have been underrepresented in research, setting them apart from other STEM disciplines [10]. To address this gap, Lucietto et al. [10] conducted a study focusing on ET students' mediation channels and psychological learning styles. Their study revealed the heightened tolerance of ET students for disorder and random thoughts in the learning environment compared to traditional engineering students [10]. Additionally, Lucietto and Berhan [11] concentrated on underrepresented students in ET, examining demographics like gender, age, ethnicity, initial major, years in school, and transfer status, and contrasting with those in the traditional engineering discipline. Nevertheless, there is limited research that combines objective and subjective approaches to explore and compare the academic success of transfer students within the ET field, especially those enrolled in the ETS program, with their traditional engineering transfer peers.

Our study primarily focuses on transfer students participating in the Engineering Technology Scholars – IMProving Retention and Student Success (ETS-IMPRESS or ETS) program, a National Science Foundation-funded initiative aimed at supporting underrepresented students in ET and related fields. This program is dedicated to enhancing the retention and success of these students by providing a comprehensive range of support.

ETS-IMPRESS addresses financial assistance by alleviating the financial burden for underrepresented students pursuing degrees in applied ET fields. Simultaneously, it offers academic support through the honors program, encompassing mentoring, workshops, seminars, reflection

writings, and tailored resources to improve retention rates [12]. These services are crucial for students to navigate their program's academic demands effectively and stay on track to graduate.

Furthermore, ETS-IMPRESS has a broader mission to increase the representation of first-generation, underrepresented students, women, and veterans in ET degree programs. Since its launch in 2018, the program has not only recruited first-year scholars but also successfully enrolled 12 transfer students in majors such as cybersecurity, computer network & system administration, electrical engineering technology, mechanical engineering technology, and mechatronics. Initiatives like ETS-IMPRESS provide financial relief and foster a supportive community and resources that empower students to excel academically [13], ultimately contributing to greater diversity and inclusion in ET professions.

This study focuses on examining whether participation in the ETS-IMPRESS program positively impacts the performance, retention rates, and time to graduation of ETS transfer students majoring in ET, in contrast to transfer students pursuing traditional engineering degrees. We assume that the academic experience in conventional engineering programs differs from that in ET degree. Traditional engineering programs emphasize mathematical and scientific principles for designing and innovating complex systems and solutions, often preparing students for research, development, and design engineering roles. In contrast, ET fields prioritize the application of established engineering principles and practical skills to facilitate technology implementation, maintenance, and troubleshooting, typically leading to careers in areas like manufacturing, construction, and technical support [10].

In summary, this study adopts a mixed-methods research approach to examine the preparedness of ETS transfer students for academic success, comparing them to their peers following traditional engineering pathways. Both groups transition from 2-year colleges to the same 4-year university. Additionally, we aim to gain insight into their experiences and perspectives as they navigate the transition. These measures provide a deeper understanding of the academic success of academically talented yet financially underserved ETS transfer students in the hands-on ET disciplines.

2. Methodology

This study has undergone a review process and has received an exemption from the university's Institutional Review Board (IRB).

2.1 Participants

Our study comprises two groups: ETS-IMPRESS transfer students in ET-related majors (12 individuals) and traditional engineering transfer students (469 individuals). The number of participants varies annually in our cross-year study, which tracks the same individuals until they graduate. ETS transfer students were recruited from 2-year colleges with GPAs averaging 3.0 or higher, recommendations from their institutions, and financial disadvantages. They were required to enroll in the honors program with expectations of achieving academic performance at the same level as their fellow engineering transfer students on campus.

2.2 Assessment Metrics

2.2.1 Objective measures. We evaluated academic achievement using spring GPA, retention rate, and time to graduation. Spring GPA represents the entire year's academic progress following the fall transfer. Retention rate tracks the proportion advancing from one academic year to the next, and time to graduation measures degree pursuit duration. This objective assessment included all ETS and engineering transfer students on campus and used data from the Institutional Research Office from fall 2018 to spring 2023, aligning with the ETS-IMPRESS program's initiation.

2.2.2 Subjective measures. To assess student preparedness and transition experiences, we designed a survey distributed via Qualtrics. It covers

- Preparedness scale (5-point Likert scale):
Please rate your preparedness for academic and future career success after transferring from a 2-year college to Michigan Tech using a scale from 1 (Completely unprepared) to 5 (Completely prepared).
- Open-ended questions about most and least prepared subjects:
In your opinion, which two subjects most prepared you for this transition?
In your opinion, which two subjects least prepared you for this transition?
- Reflections on 2-year college experiences:
Aside from academics, please share two 2-year college experiences that contributed to your preparedness for this transition.

This comparison applies to both ETS and traditional engineering transfer students.

2.3 Design and Procedure

The subjective survey was conducted in May 2023, with the participant population sourced from the Student Affairs Information System on campus. We employed a between-subject design and utilized the R programming language (version 1.3.959) for data visualization and analysis. We examined the difference in preparedness between ETS transfer students and the conventional engineering students using the Welch two-sample t-tests. Additionally, the same statistical analysis was applied to assess the objective metrics.

3. Results

3.1 Objective Assessment between ETS and Traditional Engineering Transfer Students

3.1.1 Overall GPA comparison. Table 1 displays averaged Spring GPA data for ETS and traditional engineering transfer student groups over multiple academic years, along with t-test results comparing their GPAs. Statistically, no significant differences in overall GPA emerged between ETS and traditional engineering transfer student cohorts since the inception of the ETS program in 2018. This indicates consistent academic performance similarity without substantial distinctions.

Table 1. Averaged spring GPA comparison and t-test results (2018-19 to 2022-23).

Year	Group	Cohort	Averaged Spring GPA	P-Value
2018-19	ETS	4	3.28	0.455
	Traditional	100	3.01	
2019-20	ETS	2	3.27	0.309
	Traditional	87	3.49	
2020-21	ETS	0	3.52	0.498
	Traditional	93	3.29	
2021-22	ETS	4	2.86	0.435
	Traditional	100	3.16	
2022-23	ETS	2	3.37	0.824
	Traditional	89	3.29	

3.1.2. Retention rate comparison. Table 2 provides details on cohort sizes and the annual progression percentages of students in each group, spotlighting cases of attrition or completion within the ETS cohort. It tracks each cohort year determining if the students returned after Year 1 (retention), received a degree after Year 1 (completion), or dropped out after Year 1 (attrition). The results reveal fluctuations in retention rates across academic years and between ETS and traditional engineering transfer student groups. ETS cohorts experienced higher attrition rates in specific years, while traditional cohorts demonstrated a higher percentage of students progressing in their academic pursuits overall. Overall, ETS transfer students consistently progressed through each academic year.

Table 2. Retention rates and progression of ETS and traditional engineering transfer students.

Year	Group	Cohort	After Year 1	After Year 2	After Year 3	After Year 4
2018-19	ETS	4	100%	75% (25% Completion)	50% (25% Completion, 25% Attrition)	0% (75% Completion, 25% Attrition)
	Traditional	100	93%	83%	51%	15%
2019-20	ETS	2	100%	0% (100% Completion)	0% (100% Completion)	
	Traditional	87	87%	83%	43%	
2020-21	ETS	0	N/A	N/A		
	Traditional	93	86%	70%		
2021-22	ETS	4	75% (25% Attrition)			
	Traditional	100	88% (12% Attrition)			
2022-23	ETS	2	N/A			
	Traditional	89	N/A			

3.1.3 Time to graduation comparison. Table 3 illustrates the average time to graduate for ETS and traditional engineering transfer students from 2018 to 2021. ETS transfer students generally completed their degrees more quickly than traditional engineering students. However, it is

important to note that ETS group sizes varied annually, and during the COVID-19 period, no ETS student data were available.

Table 3. Average time to graduate for ETS and traditional engineering transfer students (2018-2021).

Year	Group	Cohort	Average Time to Graduate (Years)
2018-19	ETS	3	2.7
	Traditional	75	3.1
2019-20	ETS	2	1.7
	Traditional	44	2.7
2020-21	ETS	0	-
	Traditional	10	2.2

3.2 Subjective Assessments between ETS and Traditional Engineering Transfer Students

3.2.1 Student preparedness. The survey yielded responses from four out of 12 ETS transfer students, indicating a response rate of 33.33%. In contrast, 52 out of 469 traditional engineering transfer students responded, reflecting an 11.09% response rate. Among the respondents, 25% of ETS transfer students and 83% of traditional engineering transfer students reported feeling somewhat or completely prepared for academic and career success following their transition from a 2-year college to a 4-year university. Additionally, 50% of ETS transfer students and 4% of traditional engineering transfer students felt neither prepared nor unprepared. However, it is worth noting that 25% of ETS transfer students reported feeling somewhat unprepared, compared to 13% of traditional engineering transfer students, as illustrated in Figure 1.

When comparing self-reported academic and career preparedness between ETS and traditional engineering transfer students (mean = 3 & 4.1, $t = -2.586$, $df = 3.734$, $p = 0.065$, Cohen's $d = 1.120$), key insights emerge. The t -value of -2.586 indicates a significant difference in preparedness. With a degree of freedom of 3.734, accounting for variability, the p -value of 0.065 suggests borderline significance. Cohen's d at 1.120 highlights a substantial standardized difference. While not meeting the conventional p -value threshold ($p < 0.05$), these findings hint at a potential trend toward similarity in perceived preparedness.

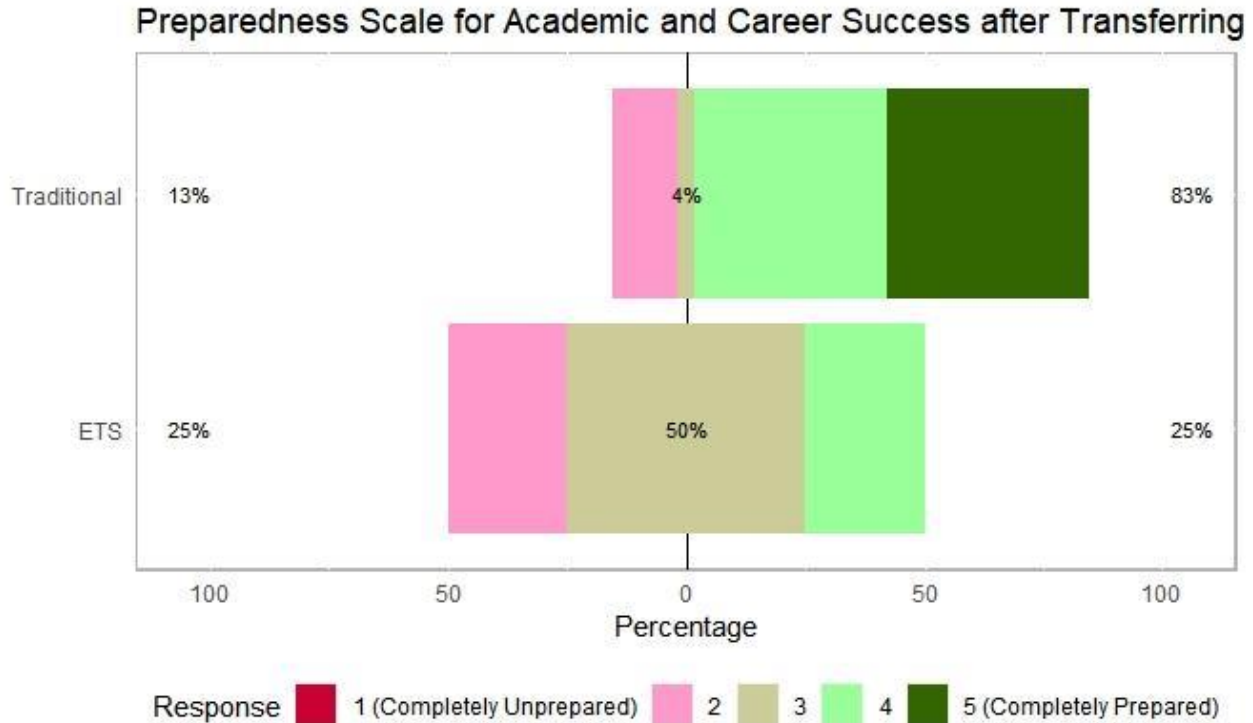


Fig. 1. Frequency distributions of preparedness mean results for ETS and traditional engineering transfer students. For example, in the ETS cohort, there is an equal distribution of 25% between “completely unprepared” and “somehow unprepared” compared to “somewhat prepared” and “completely prepared.”

3.2.2 Most prepared and least prepared subjects. Table 4 highlights the subjects that most and least prepared ETS and traditional engineering transfer students for their engineering studies. Both groups SHARED similar opinions, emphasizing mathematics and engineering courses as the most prepared subjects and social science and humanities courses as the least prepared. ETS students specifically valued CAD/SOLIDWORKS modeling and measurements and instrumentations courses in their preparation. This highlighted focus can be attributed to their specific interest in transitioning to hands-on ET fields.

Table 4. Most prepared and least prepared subjects for ETS and traditional engineering transfer students.

Subjects that Most Prepared		Subjects that Least Prepared	
ETS	Traditional	ETS	Traditional
1. CAD/Solid works Modeling	1. Mathematics (Calculus, etc.)	1. Social Science	1. Social Science
2. Measurements and Instrumentations Courses	2. Engineering Courses	2. Humanities	2. Humanities
3. Mathematics	3. Chemistry		3. Economics
4. Communication	4. Physics		4. Circuits Courses

	5. English Composition		5. Mathematics
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3.2.3 Reflections on 2-year college experiences. Beyond academics, non-academic experiences contributed to students' readiness for a 4-year university. These experiences enhance personal growth, adaptability, and self-confidence, translating into versatile skills and strategies applicable to both academic and professional contexts [14]. Below is an analysis of the critical non-academic experiences and factors that ETS students have reported as beneficial:

- *Dormitory experience:* Living in dorms fosters life skills, social adaptability, time management, and independence, vital when transitioning to campus life [15].
- *Time management:* Balancing academics with responsibilities is critical for success in higher education.
- *Internships:* Provide practical skills and industry exposure, enhancing competitiveness.
- *Honors seminars:* Foster critical thinking and research skills, preparing students for academic rigor.
- *LeaderShape:* Develops leadership, teamwork, and personal growth skills.
- *Enterprise program:* Fosters entrepreneurship and project management experience.
- *Smaller college routine:* Smaller classes and campuses create a nurturing environment, easing the transition to larger institutions.

These experiences enrich students' overall readiness for their academic and professional journeys at 4-year universities.

4. Conclusion and Future Work

In this study we examined ETS transfer students' academic performance, subjective preparedness, and non-academic experiences, contrasting them with their counterparts in traditional engineering transfer programs. We found no statistically significant GPA differences between the two groups, suggesting a consistent level of academic achievement among ETS transfer students. While retention rates displayed variation, ETS students exhibited a commitment to progressing through each academic year, despite occasional attrition. Additionally, ETS students tended to achieve faster graduation, though ongoing monitoring is crucial due to sample size limitation and data fluctuations over the years.

Subjective assessment revealed that, although ETS students reported somewhat lower prepared, statistical analysis indicated a trend toward similarity in perceived preparedness. Both groups recognized the importance of mathematics and engineering courses in their preparedness, while social science and humanities courses were viewed as less preparatory. Furthermore, ETS students

emphasized the importance of hands-on experiences and specialized coursework. Beyond academics, non-academic experiences such as dormitory living, time management skills, internships, and participation in leadership programs contributed to students' readiness for transitioning to a 4-year institution. In accordance with Berger and Malaney's insights [6], proactive preparation for the transition is essential for transfer students' academic success and positive experiences.

With these findings in mind, future research should delve into the factors influencing these perceptions and explore innovative strategies to enhance academic and non-academic support systems for transfer students. We acknowledge limitations stemming from the relatively small ETS student sample size, enrollment variation from year to year, and diverse progress levels within the program, potentially affecting the applicability and generalizability of our findings.

Looking ahead, our commitment remains strong in promoting student engagement, within and beyond the classroom, fostering peers and faculty interactions, and stimulating active academic and social involvement for enhanced academic and social adaptation at 4-year institutions [8], [16]. Our array of ETS program and services, encompassing summer bridge program, research mentorships, career support, mental health services, community-building activities, and participation in honors program seminars is designed to develop strategies that enhance both student academic success and engagement [12], [14], [17].

We acknowledge that gaining comprehensive insights will require time as we expand our scholar pool within the program. Our future work will explore our students' transition into the workforce and assess their career outcomes and enable a comparative analysis with those traditional engineering transfer peers. This endeavor holds the potential to shed light on the enduring impact of the ETS-IMPRESS program on students' professional journeys.

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Biographies

SARAH (YIN YIN) TAN, PhD, is a research assistant professor in the Department of Cognitive and Learning Sciences at Michigan Technological University. She received an MBA degree and a PhD degree in Applied Cognitive Sciences and Human Factors Program, both from Michigan Tech. Her research program involves using complementary methods (e.g., statistical modeling and analytics, psychological assessment) to evaluate how individual differences are important and impact behaviors at a cultural, social, and behavioral level. She has served as a project evaluator and student learning assessment specialist in the multiple NSF-funded projects.

SONG-LIN YANG, PhD, is a professor in the Department of Mechanical Engineering and Engineering Mechanics at Michigan Technological University. He earned his PhD in Mechanical Engineering from the University of Florida.

Proficient in his field, he specializes in computational fluid dynamics and heat transfer. In recognition of his contributions, he is honored as a fellow of the American Society of Mechanical Engineers.

DAVID M. LABYAK, PhD, is an assistant professor in the Manufacturing and Mechanical Engineering Technology Department at Michigan Tech, teaching in the area of machine design, finite element analysis, mechatronics, and Industry 4.0 Concepts. He is in his sixth year of teaching at Michigan Tech. Prior to that, he spent 25 years in the automotive, mining, aerospace, and engineering consulting industries. His background includes sheet metal fabrication, machinability of metals, product assembly, finite element analysis, as well as noise and vibration analysis.