A Longitudinal Investigation of International Graduate Students' First-Year Experiences in U.S. Engineering Programs

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Keywords: Attrition, longitudinal study, SMS, time series data, International doctoral students, Engineering

Abstract

The purpose of this full research paper is to explore international engineering graduate students' experiences in U.S. graduate programs through one year of short message service (SMS) (i.e., text message) survey data. Although international graduate students constitute a high proportion of engineering students in U.S. higher education contexts, there are few studies that specifically center them to contextualize their experiences. International graduate students experience unique challenges, such as acculturation, isolation, and visa status, that impact attrition and student well-being. Previous studies are mainly focused on acculturation or language problems for students across disciplines. For engineering disciplines, the expectation of English language proficiency is different than that of other majors like humanities, and engineering students may rely on mathematical and experimental data more heavily than English proficiency to perform well in their research. Therefore, understanding how international graduate students reflect on their experiences highlights their uniqueness within engineering contexts, separating them from the other disciplines of international students. The first year of graduate school is a pivotal period for international graduate students with regard to adapting to a new culture and norms. As part of a larger, NSF-funded study on graduate-level attrition, persistence, and graduate student experiences, we used SMS surveys to follow n = 19 first-year international engineering PhD students from October 31st, 2022, to November 3rd, 2023, surveying them three times per week. This paper offers a novel view of students, presenting a year's worth of time series results with a population, first-year PhD international engineering students, that are not typically studied. Findings indicate that although first-year international students rarely considered leaving their programs, nor reflected that their stress related to school or life was overwhelming, their data show decreasing trends in the areas of satisfaction with advisor relationships, support networks, cost, goals, and quality of life and work. Together, these results imply that students' acclimation process to graduate school in the U.S. is perhaps not happening innately. Further, our findings suggest future research should explore the variations between international students from different countries as they have different cultural backgrounds that may contribute to or influence their experiences.

Introduction, Literature Review, and Theoretical Framing

In 2022, 197,183 F-1 visa-holding students, which constitutes 16.1% of the doctoral programs in the U.S., were pursuing doctoral degrees [1]. Specifically, in graduate engineering programs, there was a notable increase in international student enrollment. According to the 2022 ASEE By the Numbers, for M.S. degree enrollments, the ratio stood at 40.2% international students; for doctoral enrollments, it was 41.7% international students [2]. This ratio underscores the central role played by international graduate students in engineering education, far surpassing their presence in undergraduate programs (only 7.9%) or other disciplines within graduate schools. International students represent a vital resource for the engineering discipline, enriching program enrollment and serving as potential research professionals in industry and academia. Their engagement is

pivotal in sustaining the field's dynamism and fostering a workforce capable of meeting the demands of an increasingly complex and globalized technological landscape [3]. Hence, understanding this demographic is integral to a holistic understanding of the broader landscape of engineering programs in the U.S.

Researchers have outlined international students' cross-cultural challenges, regardless of their country of origin or field of study [4]-[9]. For a substantial proportion of international students, both at the undergraduate and graduate levels, the process of interaction and adaptation to a new society has proven to be arduous [10], [11]. Furthermore, the influence of cultural differences has emerged as a prominent factor shaping their acculturation style. Curtin [12] and Glass [13] have reported that international students may have encountered more adverse experiences when compared to their domestic students. Trice [14] explored the viewpoints of faculty members across four academic departments—architecture, public health, mechanical engineering, and materials science and engineering—pertaining to international graduate students. A recurring observation among faculty members was the challenge of English language proficiency. The temporary residence status of international students (i.e., F-1 visas), in contrast to that of domestic peers and other immigrant groups, may contribute to the different contexts of international students' experiences [15], [16]. International graduate students' primary emphasis tends to be on academic success rather than cross-cultural integration or language learning [17]. They experience a distinctive academic environment, influenced by the limited timeframe to pursue Master's or Ph.D. qualifications. Challenges such as the urgency to fulfill degree requirements within the confines of visa restrictions are prevalent. Moreover, these students often have access to an extensive support network, which is predominantly utilized to facilitate interaction with peers from their own countries rather than with domestic students [18]-[20]. The prerequisite of meeting certain bars on English proficiency exams like the TOEFL and GRE suggests that these students possess a foundational competency in the English language [21]. Research on international students is often limited to studying their language skills and cultural adaptation rather than focusing on how they learn and interact within their academic programs. This narrow scope of knowledge about international students fails to fully capture their unique academic context, which is crucial for providing adequate support for their adjustment and successful completion of their degrees [22], [23].

The diversity and linguistic variations among international students are also profound. For instance, as reported by SEVIS [1], international students come from over 225 different countries. Research of this nature largely depends on the investigator's cultural background and the sample group's demographics. The dynamics in graduate programs can be more intricate [24], as graduate students often collaborate with their lab mates and advisors, who may or may not have international academic backgrounds. These interactions can become even more complex due to language obstacles and diverse cultural backgrounds, leading researchers to focus on student populations that share common ground as them (i.e., the same nationality, same race, or same institution) [10], [25], [26].

We focused on how international graduate students adapt to engineering programs instead of focusing on language and cultural differences. Engineering education has scrutinized its pedagogical framework to enhance diversity and inclusiveness within its curriculum. Research has investigated engineering attrition through the lens of identity theory and sociological theory [27]-[32]. In an effort to understand and support engineering graduate students better, Berdanier et al., [27] investigated factors influencing master's level attrition, highlighting the impact of advisors, support networks, and financial considerations, among others. Choe and Borrego [28] analyzed the engineering identity model initially proposed by Godwin [29] in the context of graduate education. Their study confirmed that the measures used to assess undergraduate engineering identity also apply to graduate students. They discovered that for graduate students, interpersonal skills were a more significant indicator of identity than mere competence, owing to the professional demands of graduate education, which include advanced communication and research skills. The study statistically established a positive link between a strong engineering identity and persistence in completing engineering programs. However, it also noted a gap in fully understanding international students' engineering identity reflections, suggesting that their socialization and experience might significantly differ from those of domestic students. One implication of this difference is the paradox of international students encountering more obstacles yet exhibiting higher completion rates than their domestic peers [12]. Therefore, we employed the Graduate Attrition Decisions (GrAD) model [27], which provides a framework for factors impacting student degree completion. The model has six main themes: Advisor, Support Network, Cost, Goals, Quality of Life and Work, and Perception by Others. These themes are crucial in ensuring students thrive in their doctoral programs. To better understand international students' experiences, we asked them to reflect on these themes and share how they adjust and feel supported.

Adjusting to a new academic and cultural environment unfolds over time, necessitating a longitudinal study design to comprehend international students' adaptation progress fully. We used an SMS study to collect data on the experiences of first-year international engineering graduate students. By focusing on their academic programs in the early stages, our study leverages longitudinal survey data to outline their initial experiences. This is the foundational step in developing a comprehensive understanding of the change in international students' experiences.

Methods

Recruitment This study is an extension of a prior project that primarily investigated attrition of domestic students at the Master's level within engineering disciplines [33]. For data collection, we utilized longitudinal surveys distributed through SMS text messaging on cellphones from October 31st, 2022, to November 3rd, 2023. Students were recruited from the top 50 institutions granting engineering Master's and Ph.D. degrees based on [34]. We recruited 25 first-year international graduate students in engineering across the U.S. Six participants stopped participating during the data collection, we had 19 participants for the analysis. The demographic information of these participants, including their home countries and genders, is in Table 1. The limited resources for SMS distribution over an extended period necessitated a more focused group to examine the evolution of international students' experiences. Our analysis centered on first-year international graduate students because we know that socialization in graduate programs is impactful earlier on.

The specification is grounded in acculturation theory [7], which suggests that the adjustment and integration into the academic and host country culture are most critical during the initial phases of their educational journey.

Table 1. Demographic information of participants

Characteristics		N (%)
Gender	Woman	8
	Man	11
Country of origin	China	3
	India	5
	South Korea	4
	Vietnam	1
	Taiwan	1
	Canada	1
	Peru	1
	Nepal	1
	Bangladesh	1
	France	1
Ph.D. program years based on Fall 2022	1st year	19

Survey In order to overcome the limitation of a small number of participants for statistics, we use longitudinal survey data. This survey is based on the GrAD model [27], which provides a framework for understanding engineering graduate attrition. This contains questions regarding confidence, stress, advisor, belongingness, support network, quality of life and work, cost, goals, motivation, etc. For more information on the specific questions asked, refer to Appendix A or our previous work describing how the survey was created [33]. The questions were formatted on a Likert-type scale from 1 (strongly disagree) to 7 (strongly agree), except *Q9*. *Q9 intention to leave* asked participants' intention to leave their program by contemplating the frequency within a month from 1 = Never to 7 = Always.

The survey was distributed through text messages at 3 PM (participant's local time) every Monday, Wednesday, and Friday. In these messages, participants received two daily questions on Monday, Wednesday, and Friday. On Fridays, participants received six additional questions (weekly survey) to two daily questions. Depending on the cycle, participants had four more questions once in four weeks and ten more questions once in four months in addition to the daily and weekly surveys. This different frequency is because there are monthly and semesterly survey items that differ less in response than the questions asked every other day. We explored the validation of this longitudinal SMS survey in previous papers [33], [35].

Analysis In statistical analysis, the goal is often to apply patterns observed in a sample to a broader population. However, this approach can inadvertently exclude groups that do not fit the norm. This tendency is evident in research within engineering disciplines, which has historically pertained to the white male demographic, thereby potentially overlooking the experiences of racial and socioeconomic minority groups. To bridge this gap, there is a growing trend toward adopting person-centered approaches and qualitative research [36]-[38]. These methods provide in-depth insights into specific groups, which is especially beneficial for studying populations typically represented in small numbers.

Understanding international students is crucial for a comprehensive view of engineering graduate education. However, initiating a study with a large and diverse international student population across the U.S. is difficult due to practical constraints. To overcome this, we propose a longitudinal study from the perspective of a person-centered approach. This approach prioritized the nuanced interpretation of unique experiences over aggregate prediction models. We aim to capture the richness and diversity of the international students' experiences as they navigate their first year in engineering graduate programs to gain a foundational understanding for future research encompassing various international students.

This longitudinal study collected data were collected across 159 dates from 19 participants. Initially, we computed descriptive statistics, including means and standard deviations for each survey question, to establish tendencies across all time points and individuals. Subsequently, we conducted bivariate correlational analyses to examine the relationships between the survey questions.

While calculating means and standard deviations provided initial insights, we noticed significant fluctuations in the aggregate mean of individuals at each date, which hindered our ability to discern clear patterns. To overcome this, we employed the multiplicative method for data decomposition [39], [40], an approach that separates data into trend, seasonal, and irregular components. Focusing particularly on the trend component allowed us to analyze the mean, variability, and temporal fluctuations more effectively. This method revealed underlying trends that were not apparent initially, providing a more nuanced understanding of the data, which is important for interpreting our participants' experiences.

Results

Descriptive and Correlation Table 2 presents the Pearson correlation coefficient along with mean and standard deviation values, underscoring correlations between questionnaire items (*Q1* through *Q25*).

Notably, *Q1 degree completion confidence* had the highest average score of 5.7. The data reveals that questions related to advisor relationships (*Q3, Q15*) had relatively higher mean scores and lower standard deviation, indicating general satisfaction among first-year students. The survey responses indicate that international students rate their support networks (*Q4, Q16*) relatively high, with mean scores of 5.4 and 5.1, respectively. This suggests that they feel a certain level of support within their academic environment. However, their ratings for the development of a healthy social life (*Q25*) are notably lower, averaging 4.6, and exhibit a higher standard deviation of 1.3. This

disparity might imply that while these students have support groups, possibly consisting of peers from their own national backgrounds, these networks may not be sufficiently aiding their adjustment to the broader academic and social environment in the U.S. [41]-[43]. The higher standard deviation for *Q25* also suggests diverse experiences and perceptions regarding social life development among international students. Satisfaction with the quality of work (*Q7*) and feelings of success (*Q13*) scored lower, around 4.8 and 4.5, respectively. The differences in mean and standard deviations indicate that international students' experiences in their graduate programs are diverse. These variations imply that while certain aspects of their experiences meet with satisfaction, others present challenges that may require targeted attention for support systems for international students.

Significant results include a very strong positive correlation between *Q1 degree complete confidence* and several items (*Q3 Advisor relationships, Q4 Support Network, Q5 Belongingness, Q10 Goals, and Q11 Cost*) with $r > 0.7$ *and* $p < 0.01$. Additionally, *Q3 Advisor relationships* and *Q4 Support Network* are highly correlated ($r = .886$, $p < .01$), suggesting a link between them. A notable negative correlation exists between *Q9 intention to drop out* and *Q4 support network* ($r = -.638$, $p < .01$), indicating that students considering dropping out feel less supported. *Q10 Goal*s, *Q11 Cost*, and *Q12 Motivation* are all strongly correlated with one another. This suggests that students' goals, their perceptions of the costs associated with their program, and their motivation are closely intertwined.

Several moderate positive correlations are observed, such as between *Q1* and *Q6*. Interestingly, *Q5* Belongingness shows strong positive correlations with the majority of other items, highlighting its central role in the questionnaire's underlying construct.

Table 2. Pearson correlation between questions

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q23	Q24	Q25	M	SD
Q1 Degree complete confidence	1.00																					5.7	1.0
Q2 Stress	-.01	1.00																				4.1	1.5
Q3 Advisor relationship	.79**	.08	1.00																			5.5	0.8
Q4 Support network	.79**	-.20	.89**	1.00																		5.4	1.1
Q5 Belongingness	.87**	-.09	.93**	.95**	1.00																	5.4	1.0
Q6 Quality of life and work	.51**	.03	.85**	.79**	.75**	1.00																5.2	1.1
Q7 Quality of life and work	.57**	.05	.83**	.78**	.75**	.91**	1.00															4.8	1.2
Q9 Intention to leave	-.50**	.45	-.43	-.64**	-.61**	-.39	-.34	1.00														2.3	1.2
Q10 Goals	.73**	-.20	.76**	.85**	.85**	.76**	.78**	-.74**	1.00													5.0	0.8
Q11 Cost	.72**	-.17	.78**	.85**	.87**	.69**	.73**	-.79**	.87**	1.00												5.2	0.9
Q12 Motivation	.62**	-.23	.81**	.87**	.86**	.85**	.76**	-.68*	.85**	.88**	1.00											5.3	0.9
Q13 Productivity	.56**	-.05	.67**	.66**	.66**	.69**	.84**	-.41	.64**	.74**	.66**	1.00										4.5	1.1
Q14 Self-efficacy	.79**	-.12	.58**	.63**	.73**	.32	0.38	-.72**	.69**	.77**	.55*	.48*	1.00									5.3	1.0
Q15 Advisor relationship	.51**	.23	.61**	.46*	.54*	.30	.49*	-.18	.38	.53*	.38	.45	.39	1.00								5.6	1.0
Q16 Support network	.66**	-.08	.72**	.77**	.74**	.68**	.71**	-.63**	.75**	.78**	.73**	.65**	.53*	.56*	1.00							5.1	1.1
Q17 Passion	.59**	-.06	.73**	.78**	.75**	.77**	.75**	-.73**	.78**	.82**	.75**	.73**	.59**	.36	.86**	1.00						5.0	1.2
Q18 Motivation	-.24	.49*	-.37	-.37	-.38	-.39	-.26	.37	-.38	-.27	-.39	-.26	-.19	-.03	-.29	-.43	1.00					4.4	1.3
Q19 Motivation	.58**	-.14	.64**	.75**	.75**	.62**	.55*	-.74**	.77**	.87**	.79**	.59**	.67**	.36	.72**	.81**	-.42	1.00				4.8	1.1
Q23 Expectation	.69**	.07	.78**	.79**	.83**	.75**	.70**	-.62**	.73**	.80**	.79**	.77**	.62**	.35	.69**	.87**	-.43	.82**	1.00			4.8	1.1
Q24 Belongingness	.64**	.05	.62**	.67**	.72**	.57*	.52*	-.74**	.70**	.77**	.65**	.63**	.70**	.27	.68**	.89**	-.41	.85**	.92**	1.00		5.1	1.2
Q25 Support Network	.03	-.22	.37	.40	.31	.61**	.49*	-.45	.42	.54*	.59**	.51*	.07	.03	.42	.63**	-.41	.59**	.54*	.51*	1.00	4.6	1.3

*Note: *p < 0.05, ** p <0.01,* $|r| \geq 0.7$***: very strong correlation,*** $-0.7 < r \leq -0.6$ ***or*** $0.6 \leq r < 0.7$***: strong correlation,*** $-0.6 < r \leq -0.3$ ***or*** $0.3 \leq r < 0.6$**: moderate correlation**

Trends and observations Our analysis of correlation results suggested that the responses to our questionnaire effectively capture aspects of the participants' socialization. In order to investigate this further, we examined the changes and development processes over time through graphical visualizations. These graphs present the mean of all participants to each survey question over time. In each graph, two lines are used: a pink line with dots representing the mean of all responses at each data point and a blue line with dots showing the overall trend of these means through the multiplicative method. This dual representation allows us to observe both the immediate responses and the overarching trends over time. The x-axis represents the survey dates, and the y-axis shows the scores on a Likert-type scale.

Figure 1 presents the means and trends for *Q1 degree completion confidence* on the left and *Q2 stress* on the right. For *Q1*, we observe that the trend line (blue line) started higher than the aggregate mean (5.7) but experienced a decline beginning in June 2023. This trend may be attributed to the typical coursework load in the first year of engineering programs, where concentrated resources such as seminars and orientation sessions could initially secure students' confidence. However, the noticeable decrease in confidence during the summer break suggests a potential link between ongoing coursework and students' confidence levels.

On the other hand, *Q2 stress* shows a pattern that aligns more closely with the academic semester schedule. Notably, stress levels decreased during the Christmas break and escalated around February, late April, and May, which are typically exam periods in the academic calendar. Interestingly, there was a gradual increase in stress during the summer break periods. This might reflect the unique challenges faced by international students, who, while isolated from their cohorts, often find it difficult to visit their families abroad due to geographical and possibly financial constraints.

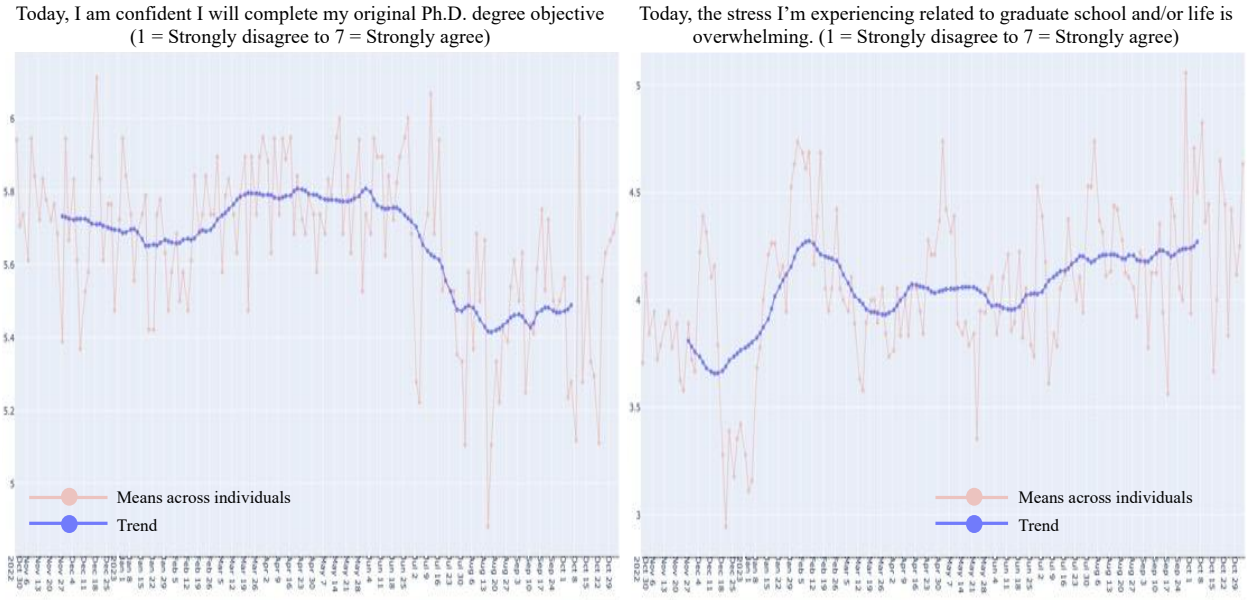

Figure 1 Means and Trend of Q1 (Left) and Q2 (Right)

These trends highlight the significant impact of academic schedules and resource availability on the psychological well-being of first-year international engineering students. They also suggest the need for targeted support during periods identified as particularly stressful or challenging for these students.

In Figure 2-(1), the trend line for *Q3 Advisor relationships* shows a downward trend over time. This observation is intriguing, as it counters the common expectation that relationships between advisors and students strengthen as they spend more time working together, leading to better understanding and improved interactions. The decline indicated by the trend line suggests that the advisor and student dynamic may be facing challenges as the program progresses.

In Figure 2-(2), the trend line for *Q4 Support network* shows a gradual decline until the end of June 2023, after which a light upward trend is observed. This increase aligns with the beginning of a new semester, suggesting that the start of academic terms may have a positive impact on the aspect of student experiences regarding support networks.

Similarly, the trend for *Q5 Belongingness* in Figure 2-(3) indicates higher mean scores during the semester, which may be attributed to the availability of abundant resources typically offered during this period. However, a noticeable decline in the mean scores is evident towards the end of each semester, around December 2022 and May 2023. This decline might reflect the culmination of academic pressures or a decrease in supportive resources as the semester concludes.

The survey data of *Q10 Goals*, *Q11 Cost*, and *Q12 Motivation* reveal a concerning trend: a consistent decline over time in Figure 2 – (4),(5),(6). The persistent downward trends of these items are alarming, as it suggests that students are experiencing increasing difficulties as they progress through their programs. During the adjustment process and socialization phase in the beginning, having positive experiences is crucial for international students to thrive and successfully pursue their degrees.

The adjustment to a new academic environment in a host country presents a multifaceted challenge for international students. While these challenges are considerable, they should not be viewed solely in a negative way. Overcoming these difficulties can lead to significant personal and professional development, equipping students with enhanced skills and resilience. However, the observed declining trends in survey responses towards the semester's end necessitate careful consideration. This pattern may signal times when international students experience heightened feelings of isolation and stress, possibly due to being away from their home country. Such insights are crucial for identifying times when these students may benefit from additional support. The data points towards the need for targeted interventions during these critical periods to mitigate stress and enhance the support network for international students, ultimately contributing to their success and well-being in the host country.

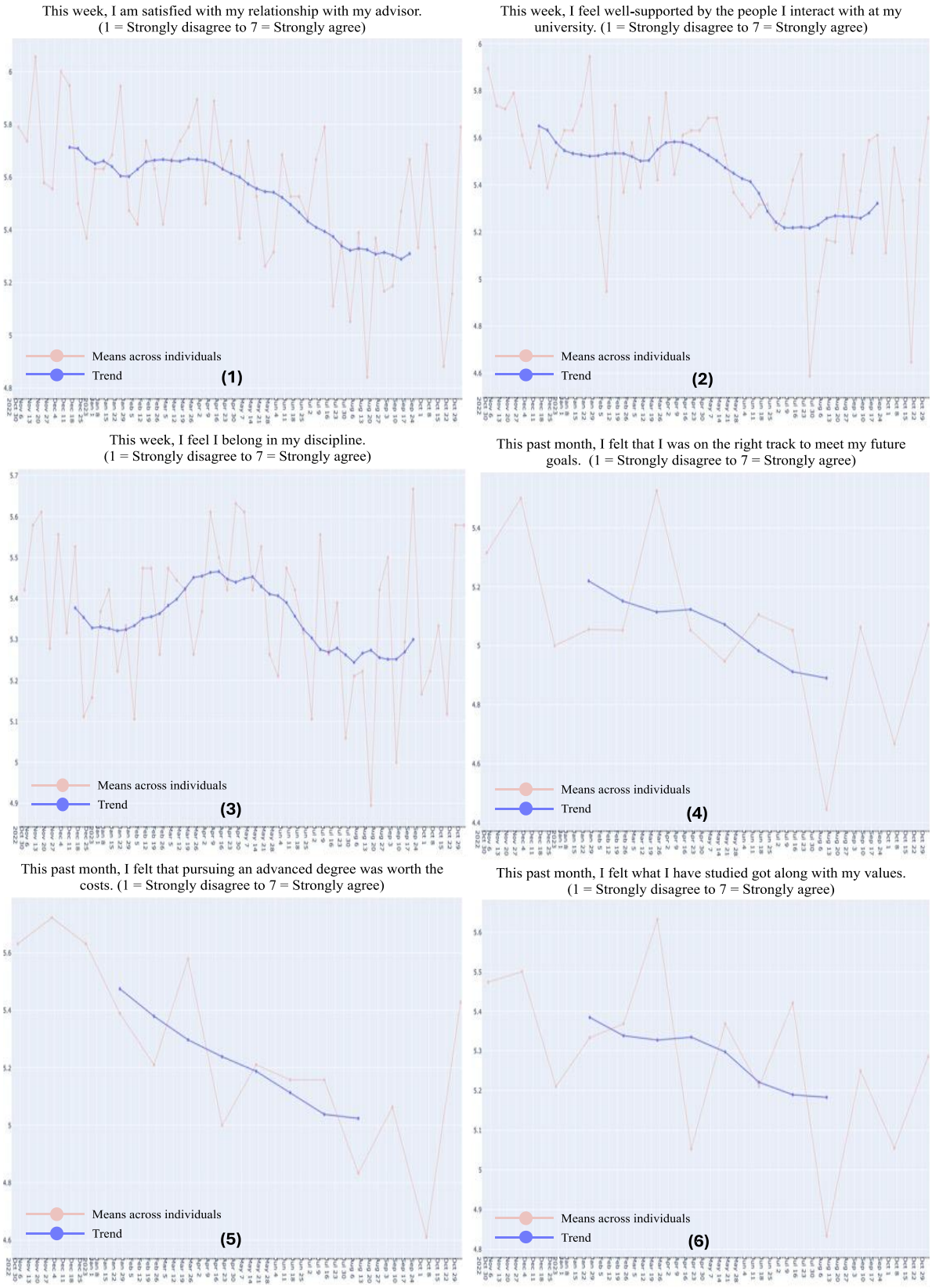

Figure 2 Means and Trend of Q3 (1), Q4 (2), Q5 (3), Q10 (4), Q11 (5), and Q12 (6)

Discussion

Overall, the strong inter-item correlations suggest high reliability in measuring the construct of socialization within the academic setting, as evidenced by the questionnaire. Such a finding implies that these elements may collectively influence students' academic experiences and decisions. For instance, a student's educational goals might be closely linked to their motivation levels, and both could be related to their perception of the costs involved in pursuing their education. These insights could be crucial for understanding how students navigate their academic journey and what factors most significantly impact their educational outcomes.

The longitudinal survey data from international students indicate a consistent decline in key metrics related to their academic and social experiences in the host country. These trends are particularly concerning as they reflect the students' ongoing challenges with adjustment and socialization. While the initial transition to a new academic environment is expected to be challenging, the continued negative trajectory suggests that these are not merely initial hurdles but persistent issues that could impede students' ability to thrive. The journey of international students in U.S. higher education involves navigating challenges in academic and cultural transitions. While education systems are designed to inculcate research skills and facilitate integration into the academic community from a sociological standpoint, the expectation of a positive progression is contradicted by the data, which indicates that these students are encountering significant struggles.

The downward trends in Figure 2 point to several critical considerations for academic institutions. First, the decline in international students' experiences emphasizes the need for and importance of creating continuous support structures. However, institutions may provide mentorship programs, counseling services, and social integration activities sensitive to students' cultural and linguistic needs. Also, international students might not be aware of these services or feel comfortable using them. The effectiveness of existing support programs must also be re-evaluated in light of these findings. Second, these results raise questions about the types of challenges faced by international students, such as academic, social, and financial stress. Maybe there are specific times in the academic year when these challenges are most acute. Understanding the nuances of these challenges is crucial for developing targeted interventions. Furthermore, the data suggests that, while international students may be equipped to handle the initial demands of their programs, it is possible that the compounding effect of sustained stressors, such as separation from once local support networks and continuous academic pressure, may gradually deplete their resilience.

Conclusion and Implications

The findings of this study serve as a call to action for higher education institutions to prioritize the well-being of international students. It is imperative that universities not only acknowledge the unique challenges this demographic group faces but also actively engage in creating environments that promote their success. Future research should dissect these trends further, investigating the specific factors that contribute to the decline in student experiences. Longitudinal studies that follow students throughout their academic journey, coupled with qualitative research that explores personal narratives, can provide a more comprehensive understanding of the international student

experience. The interplay between international and domestic students and between native languages and English adds layers of complexity to their experiences.

Contrary to our initial assumptions that socialization and academic acclimatization would naturally improve over time, the data reflects a decrease in these areas. This contradiction suggests that while students may be adapting and improving in their day-to-day lives, these advancements are not mirrored in their self-reflections. The disparity between actual progress and self-reported experiences challenges pre-existing models of student development. We recommend researchers explore their multi-dimensional facets beyond language and cultural barriers.

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Appendix

A. Survey Questions Distributed at Various Frequencies.

Distribution Frequency	Theme Assessed	Item
Daily (Monday, Wednesday, Friday)	Degree completion confidence	Q1 Today, I am confident I will complete my original Ph.D. degree objective.
	Perceived stress	Q2 Today, the stress I'm experiencing related to graduate school and/or life is overwhelming.
Weekly (Fridays)	Advisor relationship	Q3 This week, I am satisfied with my relationship with my advisor.
	Support network	Q4 This week, I feel well-supported by the people I interact with at my university.
	Belongingness	Q5 This week, I feel I belong in my discipline.
	Quality of Life and Work	Q6 This week, I like the work I do as a graduate student. Q7 This week, I am satisfied with the quality of work.
	Stressful events	Q8 Have you experienced stressful events related to graduate school and/or life this week? [Yes/No] Yes-> Could you describe the event(s)? (Text box)
Monthly (Last Friday of Month)	Intention to dropout	Q9 In the past month, how often did you consider leaving your program?
	Goals	Q10 This past month, I felt that I was on the right track to meet my future goals.
	Cost	Q11 This past month, I felt that pursuing an advanced degree was worth the costs (e.g., effort, time, money, psychological costs).
	Motivation	Q12 This past month, I felt what I have studied got along with my values (e.g., curiosity, ambition, success).
Quarterly (December, May, August, November)	Productivity perception	Q13 In the last four months, I felt successful.
	Self-efficacy	Q14 At this point, I am confident that I can complete my program of study (e.g., MS, PhD).
	Advisor relationship	Q15 At this point in my program, I consider my advisor a mentor.
	Support network	Q16 In the last four months, I felt well-supported by people in my network outside the university.
	Passion	Q17 At this point, I consider myself passionate about my research.
	Motivation	Q18 In the last four months, I was motivated to do my research because of external factors, such as external pressures from my PI, advisor, or funding requirements, being afraid of upsetting others, avoiding punishment, or avoiding feelings of guilt. Q19 In the last four months, I was motivated to do my research because of personal internal factors, such as the pleasure or the sense of accomplishment I get from conducting my research.
	Expectation vs. experiences	Q23 At this point, I feel that my experiences are well-matched with the expectations I had for graduate school before I started the program.
	Commitment	Q24 I am sure that this graduate program is the right place for me.
	Belongingness	Q25 At this point, I feel that I'm developing a healthy social life (or network) in or out of school.