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Understanding Well-Being Among Graduate Engineering Students: The Role of Social Capital and Language Proficiency*

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Graduate students in the United States face significant challenges to their psychological, psychosocial, and emotional well-being, which are exacerbated by academic demands, financial pressures, and social isolation. International graduate students also encounter additional stressors, such as cultural adjustment and language barriers, which impact their sense of belonging and academic performance. This study explores the predictors of well-being among domestic and international engineering graduate students, specifically in engineering disciplines, utilizing Seligman's PERMA model (Positive Emotion, Engagement, Relationships, Meaning, Accomplishment) as a framework. Key predictors include English language proficiency (ELP), dimensions of social capital (relational, structural, and cognitive), and student-centered institutional support. A survey of 218 graduate students revealed that relational and structural social capital, institutional support, health, and emotional regulation significantly contribute to well-being. At the same time, negative emotions and loneliness detract from well-being. Interestingly, while ELP alone was not a significant predictor, ELP's interaction with international student status highlights how linguistic challenges shape well-being in engineering graduate programs. The findings emphasize the importance of fostering supportive academic environments, promoting intercultural communication, and addressing language barriers to enhance well-being. Recommendations include targeted interventions, such as mentoring programs, emotional regulation strategies, and culturally sensitive institutional policies, to create inclusive spaces that enable graduate students to excel academically and personally. Limitations and directions for future research, such as the need for longitudinal and cross-disciplinary studies, are discussed.

Keywords: well-being, social capital, English language proficiency, graduate engineering students, international students

1. Introduction

Graduate students (GS) in the United States face significant challenges that impact their psychological, psychosocial, and emotional well-being. Both domestic and international students experience distinct stressors, with high academic demands, financial pressures, and difficulties in achieving work-life balance contributing to elevated rates of anxiety and depression. These mental health challenges among GS surpass those experienced by the general population [1, 2]. The competitive and often isolating nature of graduate programs further exacerbates these concerns, leading to widespread feelings of stress and burnout [3].

International graduate students (IGS) face additional challenges that compound their well-being issues. These include cultural adjustment, language barriers, and social isolation, which can amplify feelings of alienation and hinder a sense of belonging [4, 5]. Unlike their domestic peers, international students often lack robust social support networks and familiarity with the educational system, leaving them more vulnerable to mental health difficulties [6].

Engineering graduate students (EGS) experience unique stressors related to the demanding nature of their coursework and the solitary aspects of research. The rigorous academic standards, heavy workloads, and need for constant innovation and problem-solving can be mentally exhausting and isolating [7, 8]. These challenges contribute to high stress and burnout levels among EGS. Targeted interventions, such as peer mentoring programs and workshops on stress management, have shown promise in addressing these specific stressors [9]. Amidst the challenges GS faces, adopting a positive perspective on well-being provides a critical

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counterbalance to adversity. Well-being is widely understood as a multidimensional construct encompassing subjective well-being, including positive emotions and life satisfaction, alongside psychological and eudaimonic elements emphasizing connectedness, autonomy, achievement, and meaning as fundamental components of thriving [10]. These dimensions underscore the potential for well-being to foster growth and resilience, even in high-pressure environments such as academic settings. Psychological capital – resilience, optimism, and self-efficacy – has significantly enhanced GS's well-being [11]. Similarly, psychological safety within educational contexts plays a crucial role in reducing feelings of sadness, improving engagement, and fostering better academic outcomes [12, 13]. The PERMA model, proposed by Martin Seligman, represents an integral approach to understanding and enhancing well-being among various well-being frameworks. This model identifies five key pillars – Positive Emotion, Engagement, Relationships, Meaning, and Accomplishment – that are individually measurable and contribute independently to a fulfilling and meaningful life [14]. These insights collectively highlight the potential for fostering well-being as a pathway to thriving, even amidst significant challenges.

In addition to the five core dimensions of the PERMA model – Positive Emotion, Engagement, Relationships, Meaning, and Accomplishment – complementary measures such as negative emotions, loneliness, and health may provide a more nuanced understanding of well-being, particularly in high-stress environments like graduate education. Negative emotions, including stress, anxiety, and frustration, are known to diminish psychological resilience and hinder GS's ability to thrive academically and socially [15]. Loneliness further exacerbates these challenges, as feelings of isolation can weaken motivation, lower academic performance, and contribute to overall psychological distress [16]. This is particularly relevant for IGS, who often face barriers in building social networks due to cultural and linguistic differences, leading to intensified feelings of alienation [17]. On the other hand, health plays a crucial role in buffering against negative experiences. Physical and mental well-being are interconnected, with strong health perceptions linked to higher engagement, better stress management, and greater life satisfaction [10]

1.1 Social Capital and English Language Proficiency as Predictors of Well-being

Previous qualitative research has demonstrated that institutional and social support and English language proficiency (ELP) are significantly associated with well-being and academic identity among international GS [18]. However, existing studies have not specifically examined these relationships among STEM graduate students, particularly those in engineering. Addressing this gap is particularly important given the rigorous academic demands, social isolation, and cultural adaptation challenges EGS faces.

Social capital, defined as the networks of relationships and social interactions that provide individuals with community support and resources, plays a crucial role in the well-being and academic success of GS in the U.S. Strong social capital can help mitigate the stress of demanding academic workloads and foster a sense of belonging and support [19]. However, international students often face challenges in building social capital due to cultural and language barriers, leading to increased stress and feelings of isolation compared to their domestic counterparts [20].

Research has shown that engineering students with robust social networks experience better academic outcomes and higher program satisfaction [21]. These findings highlight the need for targeted interventions to help international students build social networks and integrate more fully into their academic communities, enhancing their educational experiences and outcomes [22].

Social capital also encompasses academic components, such as perceptions of workload, educational support, and relationships with advisors. Positive advisor relationships and a supportive academic environment have been linked to improved well-being outcomes among GS [23]. Additionally, psychosocial predictors – including social support, coping strategies, and resilience – play a crucial role in student success. GSs with strong social support networks and effective coping mechanisms are better equipped to manage the challenges of their programs [24].

The relationship between ELP and well-being is particularly significant for international students, as language proficiency is essential for academic and social adaptation. Lower levels of English proficiency have been associated with increased academic stress, social isolation, and lower overall academic performance [25, 26]. However, it is essential to distinguish between objective performance measures and subjective self-assessments of English proficiency. While research demonstrates a significant association between these two measures, subjective perceptions often lead GS to underestimate their capabilities, exacerbating anxiety and reducing participation in academic and social activities [27, 28].

Additionally, language proficiency and accent are closely tied to experiences of discrimination and social exclusion, further complicating interna-

tional graduate students' adaptation. Discrimination based on accents, often referred to as linguistic racism, reinforces stereotypes that undermine the perceived competence of international graduate students, regardless of their actual language skills [29]. Such biases hinder communication and contribute to exclusion from classroom participation, academic discussions, and social networks, particularly in environments where native-like accents are valued over effective communication [30].

These barriers are especially significant for EGS, whose field demands technical precision and collaboration, making clear and effective communication vital for success in coursework and group projects [31]. Furthermore, international graduate students must navigate unfamiliar cultural norms and communication styles that may differ from those in their home countries, adding another layer of complexity to their adjustment process. These challenges can amplify feelings of alienation and isolation, further hindering their academic and social integration [32].

Despite these obstacles, GS with higher English proficiency often exhibit better academic performance, greater confidence, and more effective integration into their programs [33]. To address these issues, institutions must implement comprehensive support systems that promote linguistic diversity, challenge discriminatory attitudes, and foster inclusive communication environments for all students [34].

1.2 Institutional Support in Graduate Education

Effective communication between students and university staff is pivotal in ensuring students are well-informed and supported. Research highlights that a lack of clarity regarding institutional policies, funding, and academic resources can create significant barriers for GS, especially for IGS unfamiliar with university procedures [35]. Universities must implement clear and transparent communication strategies that enhance GS's understanding of available resources and foster a sense of belonging [36].

Another essential component of student-centered institutional support is the availability and clarity of information regarding administrative and financial procedures. Due to fragmented and inconsistent information dissemination, GS often struggles to access key resources, such as research funding, visa regulations, and academic support services [37]. Establishing centralized information hubs and improving administrative responsiveness can significantly reduce students' stress and improve their ability to navigate institutional systems [38].

Furthermore, cultural sensitivity and inclusivity are critical for fostering a supportive academic environment, particularly for international and underrepresented students. Universities that prioritize cultural awareness through diversity initiatives, mentorship programs, and inclusive policies contribute to GS's overall well-being and academic success [39, 40]. Institutions should also collaborate among faculty, advisors, and student support services to ensure that GS receives the individualized guidance and resources they need to thrive [41].

While existing studies explore institutional support, most focus on undergraduates or isolate specific challenges like academic stress or finances. Research rarely examines how institutional support impacts domestic and IGS well-being, especially in engineering. Given this group's unique stressors, such as intensive workloads, social isolation, and cultural or linguistic barriers for IGS, understanding student-centered support is crucial. This study fills that gap by integrating communication clarity, institutional responsiveness, and cultural sensitivity into a single instrument.

1.3 Research Objectives and Context

Understanding and evaluating GS well-being through a comparative lens between domestic and international students is essential for developing targeted interventions and fostering inclusive support systems. Institutions can allocate resources effectively by identifying specific needs, ensuring equity and satisfaction among diverse student populations [25]. However, existing literature highlights a notable gap in comparative studies between these groups, emphasizing the need further to explore their distinct stressors and challenges [18].

Equally important is adopting a holistic approach to well-being, as conceptualized by Seligman's PERMA model, which emphasizes Positive emotions, Engagement, Relationships, Meaning, and Accomplishment [14]. By integrating this comprehensive framework, institutions can shift their focus from merely addressing deficits – such as anxiety and depression – to proactively fostering resilience, life satisfaction, and overall thriving. A research methodology incorporating positive psychological measures is crucial for understanding and supporting the diverse needs of GS, ultimately enhancing their success and well-being in academic environments [7, 4].

This study employs the PERMA Profiler to deepen our understanding of how specific factors influence domestic and international EGS well-being. The following questions guide the research:

- RQ1: How does ELP predict overall well-being among EGS (Engineering Graduate Students)?
- RQ2: To what extent do dimensions of Social Capital (relational, structural, and cognitive) and

institutional support contribute to variations in well-being outcomes?
- RQ3: How does the complementary PERMA model (Positive Emotion, Engagement, Relationships, Meaning, Accomplishment Model) measure (negative emotions, loneliness, and health), Social Capital, and Institutional Support predict overall well-being?
- RQ4: How does international status (compared to domestic) interact with these predictors to create disparities in well-being between the two groups?

This study hypothesizes that English Language Proficiency, dimensions of Social Capital (relational, structural, and cognitive), and Student-Centered Institutional Support will significantly predict overall well-being among EGS. Furthermore, international students are anticipated to exhibit distinct well-being profiles compared to domestic students, with their global status moderating factor in these well-being outcomes.

2. Method

2.1 Participants

Our study included 218 EGS from a Large land-grant university, of whom 136 completed the entire survey and agreed on the control questions. The final sample comprised 56% domestic and 44% international students, 63% male and 37% female. Most participants fell within the 25 to 30 years age group (60%), followed by those younger than 25 (25%) and older than 30 (15%). The participants' ages ranged from 22 to 52. Regarding marital status, 71% of respondents were single, 28% were married, and 1% were divorced. Regarding racial and ethnic identity, 58% identified as white, 30% as Asian, 3% as Black or African American, 1% as bi/multiracial, and 8% as other. Additionally, 29% of participants identified as Hispanic, 7% as bi/multiethnic, 3% as Asian alone, 1% as Black or African American alone, 1% as White alone, and 57% as some other race alone.

2.2 Instruments

Overall Well-being. The PERMA Profiler is a psychometric instrument designed to assess the dimensions of happiness and well-being among adult individuals [15]. It consists of 23 items, with respondents providing ratings on a scale ranging from 0 to 10, marked by various semantic anchors. These items collectively measure the five fundamental domains of the PERMA model, with three items allocated to each domain: Positive Emotion (e.g., ''In general, how often did you feel positive?''), Engagement (e.g., ''In general, to what extent did you feel excited and interested in things?''), Relationships (e.g., ''To what extent did you feel loved?''), Meaning (e.g., ''In general, to what extent did you feel that what you did in your life was valuable and worthwhile?''), and Achievement (e.g., ''How often did you achieve the important goals you had set for yourself?''). The instrument produces a composite score that integrates these five domains, offering a comprehensive overview of an individual's well-being status, which serves as the dependent variable in this study.

In addition to the core PERMA domains, the PERMA Profiler includes four supplementary measures that enhance the understanding of well-being. However, they are not directly categorized as well-being dimensions. These supplementary measures and sample items include Negative Emotion (e.g., ''In general, how often did you feel angry?''), Health (e.g., ''How satisfied were you with your current physical health?''), and Loneliness (a single item: ''How lonely did you feel in your daily life?''). These items provide a broader evaluation of an individual's psychological state. Reliability analysis in this study yielded Cronbach's alpha scores ranging from acceptable to excellent: PERMA (0.94), Health (0.93), and Negative Emotion (0.66).

English Language Proficiency (ELP). A well-established self-report methodology was used to determine ELP [27]. For this purpose, five distinct items previously documented in the literature served as the evaluative framework. International and domestic participants were requested to evaluate their past proficiency in listening, reading, writing, and speaking English using a 7-point Likert scale, where the range extended from 1 (indicating ''very poor'') to 7 (similar to a native speaker). Additionally, participants self-report the degree of strength associated with their foreign accent. This assessment of accent strength covered a scalar continuum, ranging from 1 (indicating ''none'') to 7 (signifying ''extremely strong''). It is worth noting that previous empirical investigations have confirmed the psychometric robustness of this assessment approach and moderate correlations between this measure and objective performance test scores. This study's internal consistency coefficient, represented by Cronbach's alpha coefficient of 0.86, affirmed the instrument's reliability and capacity to produce consistent and coherent results.

Social capital. This study assessed three types of social capital: structural, relational, and cognitive. Structural social capital (SSC) represents individuals' general network patterns in their context, and we employed a 7-point Likert scale [42]. Examples of items for cognitive social capital included statements like ''I maintained close social relationships with my cognitive'' and ''I knew some peers

on a personal level.'' Relational social capital (RSC) refers to trust and mutual obligation within relationships [42]. To measure trust, we used a three-item scale [42]. Sample items for advisor equity included statements such as ''I could always trust my department's people to help me if I needed it'' and ''I could always trust my department's people to make my job easier.'' Cognitive social capital (CSC) pertains to creating shared meaning and understanding, encompassing common language and goals [42]. We employed a three-item scale to measure shared language [43]. Sample items for cognitive capital included statements like ''my department's people, and I used common terms or jargon'' and ''my department's people, and I used understandable narrative forms to post messages.'' Previous research had reported Cronbach's alphas of 0.89, 0.92, and 0.97 for the structural, relational, and cognitive social capital scales, respectively [43].

Student-Centered Institutional Support Experience. The research team developed the Student-Centered Institutional Support Experience instrument (SCISE) for this study to evaluate GS' perceptions of their university's ability to provide effective institutional support. The instrument focuses on key dimensions such as the availability and clarity of information regarding administrative and financial procedures, the responsiveness of university staff, and their cultural sensitivity in addressing student needs. Sample items include statements such as: ''Information on administrative and financial procedures is available,'' ''The university staff is interested in understanding my situation or problem,'' and ''The university staff is aware of the different cultural backgrounds of the students.'' Responses are measured on a 7-point Likert scale ranging from 1 = Strongly Disagree to 7 = Strongly Agree. Psychometric testing of the instrument revealed a single-factor structure through exploratory factor analysis, explaining 56.9% of the total variance. Factor loadings ranged from 0.5 to 0.8, indicating strong relationships between the items and the underlying construct. Reliability analysis demonstrated high internal consistency, with a Cronbach's alpha and McDonald's Omega of 0.87. These findings support the instrument's reliability and validity for assessing the quality and inclusivity of institutional support as perceived by students.

2.3 Procedure

Methods were approved by the Institutional Review Board (IRB) office of the university, and all surveys were completed following relevant guidelines and regulations. IRB: IRB-2022-1690, Understanding international and domestic EGS's well-being: What do they need to thrive? After receiving approval from the IRB office, we created a Qualtrics survey containing the study instruments. Participants were offered the survey voluntarily, and an informed consent statement appeared at the outset of the survey. If participants agreed to the study's conditions, they proceeded to complete the survey. In cases where participants did not accept, the survey was closed. For those who chose to participate, each section of the survey featured one instrument, and the items within each section were presented randomly to prevent response patterns. Additionally, two items were strategically placed in the middle and at the bottom of the form to monitor participants' attentiveness (''If you are reading this, please select 'Disagree' as your response'' and ''What is 200+30?''. A reinforcement message was delivered between sections to encourage participants to complete the survey. It is worth noting that no payments, incentives, or costs were provided to the participants.

2.4 Data Analysis

The data analysis was conducted in a series of steps using R software. First, descriptive statistics and bivariate correlations were computed to explore the relationships between the study variables, including PERMA, ELP, SSC, RSC, CSC, SCISE, health, negative experiences, loneliness, and international status (coded as 1 = international, 0 = domestic). Hierarchical multiple regression analyses were performed to evaluate the overall well-being predictors. Three models were tested incrementally:

Step 1: The initial model included ELP, international status, and their interaction (ELP × International).

Step 2: SSC, RSC, CSC, SCISE, and their interactions with international status were added to the model.

Step 3: Health, negative experiences, loneliness, and their interactions with international status were included as additional predictors.

Changes in R^2 were calculated to assess the additional variance explained by the predictors added at each step. The statistical significance of these changes was evaluated using a hierarchical ANOVA, which compares nested regression models to determine whether adding additional predictors significantly improves model fit. Model diagnostics, including residual analysis, were performed to ensure that the assumptions of linear regression were met. All statistical tests were two-tailed, with a significance threshold set at $p < 0.05$. Results were reported using unstandardized coefficients, standard errors, t-values, p-values, and sig-

nificance levels. The analyses were designed to examine predictors' unique and interactive contributions to overall well-being while controlling for potential confounders.

3. Results

A correlation analysis was conducted to understand the relationship among the variables that impact international and domestic GS well-being. Significant positive correlations were observed between PERMA and several predictors, including RSC, SSC, SCISE, and health, suggesting that these factors contribute positively to well-being (Table 1). Conversely, negative emotions and loneliness were negatively associated with PERMA, highlighting their detrimental impact. ELP showed a weak but significant positive correlation with RSC and CSC, while negative emotions were significantly negatively correlated with ELP, RSC, and SSC (Table 1). International status was not significantly associated with most variables except ELP, where a strong negative relationship was found.

The first step of the hierarchical multiple linear regression analysis was to examine the relationship between ELP, international status, and their interaction on overall well-being. This step's intercept was statistically significant, indicating a baseline level of overall well-being. However, as shown in Table 2, neither the predictors nor their interaction showed substantial effects. The step accounted for approximately 6.7% of the variance in overall well-being, and the overall model was statistically significant ($F(3,13) = 3.15$, $p = 0.03$). These results suggest that while this step is significant, the individual predictors (define predictors) and their interaction do not independently explain variations in overall well-being.

The second multiple linear regression step examined the relationship between overall well-being, the predictors in step 1, and four dimensions of social capital and support: RSC, CSC, SSC, and SCISE. Interaction terms between international status and each dimension of social capital and support were also included (Table 3). The step explained 38.6% of the variance in overall well-being ($R2 = 0.39$) with an adjusted $R2 = 0.33$, indicating a moderate fit. This step was statistically significant ($F(11,124) = 7.09$, $p < 0.001$).

The third step of multiple linear regression analysis examined the impact of ELP, international status, social capital dimensions, health, negative experiences, and loneliness on overall well-being. Interaction terms with international status were also included (Table 4). The step explained 68.2% of the variance in overall well-being ($R2 = 0.68$), and the adjusted $R2 = 0.63$, indicating a strong fit. This step was statistically significant ($F(17,118) = 14.9$ $p < 0.001$). Significant predictors included RSC, health, and negative experiences, highlighting their role in shaping well-being. Interactions between ELP and loneliness with international status also showed a significant relationship. However, most other predictors and interactions, such as SSC and SCISE, were not statistically significant.

As part of the hierarchical regression analysis, changes in R2 were examined to assess the incremental contribution of predictors across three steps. From Step 1 to Step 2, the inclusion of RSC, CSC, SSC, and SCISE, and their interactions

Table 1. Correlations among the study's variables

	PERMA	ELP	RSC	CSC	SSC	SCISE	Hea.	Neg.	Lon.
ELP	0.20*								
RSC	0.43**	0.23**							
CSC	0.22*	0.18*	0.35**						
SSC	0.41**	0.04	0.23**	0.22*					
SCISE	0.45**	–0.09	0.40**	0.35**	0.31**				
Hea.	0.69**	0.11	0.31**	0.14	0.32**	0.44**			
Neg.	–0.66**	–0.26**	–0.27**	–0.05	–0.35**	–0.34**	–0.60**		
Lone.	–0.45**	–0.02	–0.22**	0.06	–0.16	–0.14	–0.30**	0.46**	
International	–0.05	–0.71**	–0.09	–0.01	–0.05	0.13	0.01	0.16	0.01

** Correlation is significant at the 0.01 level (2-tailed), * Correlation is significant at the 0.05 level (2-tailed).

Table 2. Hierarchical multiple linear regression – Step 1

Predictor	Unstandardized B	Standardized Coefficients Beta	Std. Error	*t*-value	*p*-value
Intercept	6.23		0.29	21.69	<0.001
ELP	0.05	0.13	0.07	0.63	0.53
International	0.56	0.16	0.41	1.37	0.17
ELP*International	0.11	0.21	0.09	1.24	0.22

Table 3. Hierarchical multiple linear regression – Step 2

Predictor	Unstandardized B	Standardized Coefficients Beta	Std. Error	*t*-value	*p*-value
Intercept	6.25		0.25	25.13	<0.001
ELP	0.04	0.11	0.07	0.61	0.54
RSC	**0.06**	**0.24**	**0.03**	**2.29**	**0.02**
CSC	–0.05	–0.09	0.05	–0.88	0.38
SSC	**0.08**	**0.26**	**0.03**	**2.66**	**0.01**
SCISE	**0.05**	**0.27**	**0.02**	**2.63**	**0.01**
International	0.38	0.11	0.36	1.07	0.29
ELP*International	0.08	0.16	0.08	1.00	0.32
RSC*International	–0.01	–0.03	0.04	–0.27	0.79
CSC*International	0.01	0.02	0.09	0.14	0.89
SSC*International	0.00	–0.00	0.05	–0.02	0.98
SCISE*International	0.02	0.06	0.04	0.47	0.64

Table 4. Hierarchical multiple linear regression – Step 3

Predictor	Unstandardized B	Standardized Coefficients Beta	Std. Error	*t*-value	*p*-value
Intercept	6.45		0.19	34.63	<0.001
ELP	–0.07	0.19	0.05	–1.29	0.20
RSC	**0.05**	**0.24**	**0.02**	**2.42**	**0.02**
CSC	0.05	–0.09	0.04	1.15	0.25
SSC	0.01	0.26	0.03	0.27	0.79
SCISE	0.00	0.27	0.02	0.22	0.83
Health	**0.22**	**0.30**	**0.07**	**3.11**	**0.00**
Negative	**–0.37**	**–0.41**	**0.10**	**–3.61**	**0.00**
Loneliness	–0.02	–0.04	0.05	–0.41	0.69
International	0.11	0.03	0.27	0.42	0.67
ELP*International	**0.15**	**0.28**	**0.07**	**2.28**	**0.03**
RSC*International	–0.03	–0.08	0.03	–0.88	0.38
CSC*International	–0.02	–0.02	0.07	–0.24	0.81
SSC*International	0.04	0.09	0.04	1.05	0.30
SCISE*International	0.02	0.05	0.03	0.53	0.60
Health*International	0.05	0.05	0.11	0.49	0.63
Negative*International	0.21	0.14	0.15	1.42	0.16
Loneliness*International	**–0.14**	**–0.17**	**0.07**	**–1.96**	**0.05**

with international status accounted for a significant $\Delta R2 = 0.319$. The ANOVA comparison between Step 1 and Step 2 confirmed this change as statistically significant ($F(8,124) = 8.06$ $p < 0.001$). From Step 2 to Step 3, adding health, negative experiences, loneliness, and their interactions with international status explained an additional $\Delta R2 = 0.296$. This step also resulted in a significant improvement in model fit ($F(6,118) = 18.34$ $p < 0.001$).

4. Discussion

The results show how the predictors in the research questions play different roles in the well-being prediction. English Language Proficiency and international status (versus domestic) did not independently predict well-being in Step 1. However, when relational social capital, structural social capital, and student-centered institutional support were significant contributors to GS well-being in Step 2. Health perception positively predicted well-being, while negative emotions had the opposite effect in Step 3. Additionally, in that step, international status interacted with English language proficiency and loneliness, highlighting specific factors in the model that affect that group.

Social capital emerged as a key determinant of GS well-being, particularly relational social capital, followed by structural social capital and institutional support. These findings suggest that trust, mutual support, and access to academic resources are essential for reducing stress and fostering emotional [7, 8]. In demanding programs like engineering, strong social networks enhance psychological safety, promote resilience, and improve academic

engagement [13, 20]. Research indicates that students with strong social ties report lower anxiety, greater academic motivation, and higher retention rates [10, 11]. Institutional responsiveness – through mentorship, financial clarity, and accessible resources – has been linked to higher student satisfaction and reduced attrition [7, 17]. Investing in social and institutional support is critical for well-being, academic success, and persistence in graduate education [4, 9].

Likewise, health perceptions, such as good physical health, positively influence positive emotions and enhance engagement, energy, and the ability to maintain meaningful relationships. Research has shown that health perceptions are closely linked to psychological well-being, improving key aspects such as concentration, vitality, and the ability to manage stress [44]. Moreover, emotional and psychological well-being can, in turn, positively influence physical health, establishing a bidirectional cycle in which both factors mutually reinforce each other. Additionally, wellness programs have significantly improved GSs' emotional and physical well-being while reducing burnout, further strengthening the connection between mental and physical health [45].

Negative emotions significantly adversely impacted overall well-being, as demonstrated by the highest beta recorded in Step 3. These emotions reduce the prevalence of positive emotions, hinder engagement in meaningful activities, and weaken the development of satisfying relationships [15, 14]. Engineering graduate programs impose substantial academic, social, and personal demands, which can intensify negative emotions such as anxiety, stress, and frustration [2, 7]. These emotional challenges can be further exacerbated for first-generation and international students unfamiliar with the academic and cultural environment, who may lack effective coping mechanisms and emotional regulation strategies [4, 17]. As a result, these students are at a higher risk of experiencing psychological distress and social isolation, potentially affecting their persistence and academic success [16].

The interaction between ELP and international status became a significant predictor of well-being in Step 3 of the analysis, despite ELP alone not showing significant effects in earlier models. This suggests that ELP's impact on well-being is contingent on other cultural and social variables influencing IGS' experiences. Language proficiency influences students' ability to integrate academically and socially, affecting their overall well-being [28].

A negative correlation between ELP and negative emotions further suggests that lower perceived language proficiency is linked to higher anxiety and frustration levels, reinforcing prior research that highlights the stress induced by linguistic barriers [46]. Additionally, the strong negative correlation between ELP and international status confirms that international students generally perceive greater difficulties with their linguistic competence, which can act as a barrier to social and academic integration [29]. The findings suggest that universities must address language proficiency and the broader educational and social challenges that emerge from language-related insecurities.

Similarly, loneliness and international status interacted significantly, underscoring the heightened vulnerability of international students to social isolation. The negative correlation between loneliness and overall well-being aligns with previous studies demonstrating that feelings of isolation exacerbate stress, hinder academic performance, and diminish mental health [16].

However, our findings indicate that while loneliness affects all students, its impact is particularly pronounced for IGS due to limited access to social support systems, cultural adjustment difficulties, and language barriers [17]. The challenges in accessing academic resources, peer networks, and faculty guidance further intensify international students' experiences of alienation, limiting their sense of belonging and academic confidence [46].

4.1 Limitations and Future Directions

This study has several limitations that should be considered. The self-report nature of the survey introduces potential social desirability and subjective bias. While this approach allows for personalized insights into well-being, incorporating objective academic indicators such as GPA, retention rates, and research productivity could offer an additional perspective. Moreover, the sample was drawn from a single institution in the Midwest United States, limiting generalizability to other regions, disciplines, and institutional structures. Expanding research across different geographic, cultural, and academic contexts would provide broader insights into well-being determinants.

The cross-sectional nature of the study prevents causal conclusions. A longitudinal approach would enable a deeper understanding of how well-being evolves and identify critical intervention points. Future research should explore the long-term impact of social capital, language proficiency, and institutional support on well-being, particularly in relation to student retention, performance, and career outcomes.

Another area for future investigation is the impact of perceived language proficiency on academic and social experiences. Given that ELP perceptions were strongly linked to international status, future studies should examine how language

ideologies, implicit biases, and linguistic discrimination shape academic experiences. Understanding these mechanisms could inform interventions that promote greater linguistic inclusivity and challenge language-based inequalities.

Finally, research should explore how social capital influences well-being beyond individual benefits, particularly in collective academic environments. Investigating departmental or program-wide social capital structures could provide insights into how institutional networks shape academic identity, collaboration, and success.

By addressing these gaps, future research can further refine institutional strategies that promote GS success and well-being, ensuring inclusive, supportive, and resilient academic communities.

5. Conclusion

This study provides a comprehensive understanding of the predictors of well-being among EGS, focusing on the roles of social capital, institutional support, ELP, and emotional regulation. Using the PERMA model as a framework, our findings underscore the importance of relational and structural social capital, institutional support, and health perceptions in fostering well-being, while negative emotions and loneliness emerge as significant detractors. Notably, while ELP alone was not a significant predictor, its interaction with international status highlights the complex ways linguistic challenges shape well-being in engineering graduate programs.

For IGS, these insights suggest that universities should prioritize the development of supportive environments that promote social integration, clear institutional communication, and culturally responsive policies. Creating academic and social spaces that foster trust, collaboration, and mentorship can strengthen relational and structural social capital, essential for student engagement, resilience, and retention. Enhancing institutional transparency regarding administrative and financial processes and implementing targeted language support programs can mitigate challenges faced by international students. Addressing emotional regulation and stress management through structured interventions can further bolster students' capacity to navigate academic and personal challenges.

Findings from this study also raise questions about how EGS' experiences compare to those in other disciplines or undergraduate programs. The high levels of stress and social isolation reported among EGS suggest potential differences in well-being determinants across fields. Future research should explore disciplinary variations in social capital, language adaptation, and institutional support needs to better tailor interventions across diverse student populations.

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