

Receptive English proficiency across programs in engineering education

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Article Info

Article history:

Received Dec 5, 2025

Revised Mar 5, 2026

Accepted Mar 30, 2026

Keywords:

English-medium instruction
Placement testing
Program variation
Receptive proficiency
STEM education

ABSTRACT

English proficiency is increasingly recognized as a prerequisite for disciplinary participation in science, technology, engineering and mathematics (STEM) higher education, yet large scale evidence on institutional variation among non-English-major engineering students remains limited in Vietnam. This study examined receptive English proficiency across three program types, mass, advanced, and international, using population-level placement data from 17,561 first-year engineering students over three consecutive cohorts (2022-2024). Listening and reading performance (10-990 total) was analyzed through a two-way general linear model (GLM) to assess main and interaction effects of program structure and academic year. Results indicated a consistent proficiency hierarchy (advanced>international>mass), with program type explaining the largest proportion of variance (partial $\eta^2=0.21$). Academic year demonstrated a medium effect (partial $\eta^2=0.09$), reflecting a progressive decline in cohort readiness, while the interaction effect (partial $\eta^2=0.03$) showed more pronounced decreases in the mass program. These findings suggest that English-medium environments partially buffer national level declines but cannot fully offset systemic weaknesses in receptive preparedness. Implications include differentiated instructional pathways, placement informed curriculum design, and targeted academic English support in Vietnamese-medium engineering programs. The study provides empirical evidence for equity-oriented English medium instruction (EMI) development and contributes data driven insights for policy and curriculum in STEM higher education.

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1. INTRODUCTION

English proficiency has become a critical prerequisite for participation in globalized and innovation driven higher education, particularly within science, technology, engineering and mathematics (STEM) fields where scientific communication, technical documentation, and academic knowledge exchange are predominantly conducted in English (Crystal [1]; Macaro *et al.* [2]; Pecorari and Malmström [3]; and Rose *et al.* [4]). In engineering programs, receptive skills, especially academic listening and reading, play an essential role in accessing disciplinary content, understanding technical materials, and engaging with English-medium instruction. Strengthening foundational receptive skills, therefore, has important implications for instructional design and student support, particularly in large and diverse student cohorts [5]. Empirical evidence from English medium instruction (EMI) contexts further shows that students' English proficiency and language related challenges significantly predict academic success, highlighting the central

role of linguistic readiness in EMI programs [6], [7]. Beyond academic performance, English proficiency in EMI settings has also been shown to shape learners' self-efficacy, engagement, and satisfaction, underscoring the affective consequences of linguistic readiness [8]. However, structural disparities remain evident between English-medium and traditional language programs, especially in non-English-major populations [1].

In Vietnam, English has been framed not merely as a foreign language but as a strategic instrument for technological innovation, digital transformation, and national competitiveness [9]–[11]. Recent policy directions, including national initiatives for EMI expansion in higher education, emphasize the integration of English into professional and disciplinary development, with engineering students positioned as a core target group. Yet empirical evidence consistently reports gaps between technical competence and English readiness, particularly at university entry, where variation across program types remains poorly understood [2], [12], [13]. A major systematic review indicates that EMI supports academic language development in higher education, but EMI policies and practices may also reproduce inequalities in students' English preparedness across programs [2], [14].

Despite growing national emphasis on EMI and STEM internationalization, large scale quantitative evidence of institutional variation in English proficiency remains scarce. Existing studies tend to rely on small samples, self-reported preparedness, or descriptive comparisons that lack inferential analysis and effect-size interpretation [2]. There is, therefore, limited empirical understanding of how different program structures, Vietnamese-medium, advanced English-oriented, or full EMI pathways, shape receptive-skill profiles of incoming engineering students. Such gaps constrain data driven curriculum planning and hinder equitable implementation of EMI in STEM contexts. Recent Vietnamese evidence indicates that EMI participation supports English proficiency development but yields uneven outcomes across learners [12].

This study addresses this gap using population level placement data from 17,561 first-year engineering students across three consecutive cohorts and three institutional program structures. Employing a two-way general linear model (GLM), the study examines main effects of program type and academic year on receptive English proficiency and interaction effects indicating whether cohort-level changes differ across institutional tracks. By quantifying both structural and temporal variation, the study provides empirical evidence capable of informing placement policy, curriculum design, and equitable EMI development in Vietnamese engineering education. The findings also contribute to international literature by demonstrating how institutional language structures operate as determinants of academic English readiness in STEM. These concerns carry urgency in national policy contexts where EMI expansion is closely tied to Vietnam's long-term goals for technological innovation and global STEM integration. Figure 1 presents the conceptual model linking national EMI policy, institutional program structure, receptive English exposure, and academic readiness in engineering education.

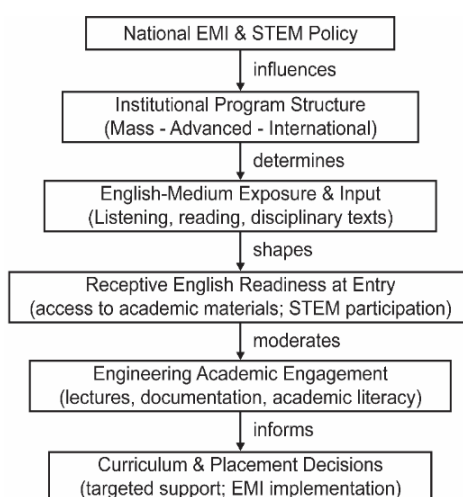


Figure 1. Conceptual model of receptive English readiness in Vietnamese engineering education

2. THEORETICAL BASIS FOR THE STUDY

2.1. English proficiency and academic readiness in STEM education

Across STEM focused higher education, English proficiency constitutes a prerequisite for academic participation, disciplinary knowledge construction, and international collaboration, particularly in digital and innovation driven fields. Students in engineering and technology programs must engage with

English-medium textbooks, technical documentation, and scientific literature, positioning receptive skills, particularly academic listening and reading, as foundations of disciplinary learning [15]. However, non-English-major STEM students frequently experience a misalignment between technical competence and language proficiency, resulting in participation barriers in EMI classrooms and limited access to global research networks [2], [6]. English competence is often positioned as a resource for innovation led development, digital transformation, and international competitiveness. Yet empirical research consistently reports substantial disparities in language readiness between STEM and non-STEM populations, and within engineering cohorts themselves [6]. These patterns underline the need for systematic monitoring of English readiness through empirically validated assessment mechanisms at the point of university entry. Receptive proficiency has been shown to predict disciplinary engagement and academic performance in STEM [15].

2.2. English-medium instruction and program variation

International EMI studies suggest improved exposure to academic language, authentic communicative input, and access to global disciplinary knowledge [2], [16], [17]. In Vietnam, empirical studies have documented persistent challenges in EMI implementation, including heterogeneous student intake, uneven English readiness, and structural constraints that limit equitable access to English rich learning environments [13]. Recent English for specific purposes or ESP oriented research indicates that Vietnamese engineering curricula remain heavily translation oriented and exam driven, with insufficient sustained language input and authentic task engagement [12]. Comparative evidence in other Asian tertiary contexts confirms the strong influence of program level English exposure on academic English outcomes [2]. Several recent studies have explored the interface between English proficiency and academic success in English Medium Instruction courses. For example, Kamaşak and Şahan [7] found that language related challenges and perceived English proficiency significantly predicted academic success in EMI courses, underscoring the need for targeted language support in EMI programs. Collectively, these studies suggest that the degree of English-medium exposure (mass, advanced, international programs) functions as a structural determinant of language outcomes, although empirical comparisons in Vietnam remain limited and predominantly small scale. Recent evidence further indicates that EMI participation shapes learners' longer-term language development and perceived career prospects, positioning EMI as a form of academic and professional capital [18]. More evidence shows that English proficiency in EMI contexts is closely linked to learners' self-efficacy, engagement, and satisfaction, reinforcing the importance of linguistic readiness in EMI program design [8].

2.3. English placement testing and receptive-skill assessment

Placement testing constitutes a critical mechanism for aligning instruction with actual learner profiles, supporting curriculum differentiation, and ensuring valid learner placement and progression [19]–[21]. Figueras *et al.* [22] emphasized the importance of construct validity and contextual alignment in academic language assessment, arguing that placement systems must reflect authentic communicative and disciplinary demands rather than isolated grammar knowledge. Large scale evidence in Asian tertiary EFL systems demonstrates that structured placement testing predicts subsequent academic achievement and supports differentiated instruction [2], [6], [23]. In STEM disciplines, receptive skill proficiency strongly correlates with academic readiness, disciplinary engagement, and success in lecture-based learning [15]. Nonetheless, receptive skill assessment in Vietnamese STEM programs remains underdocumented, particularly at entry and across institutional program types.

2.4. English proficiency research in Vietnam

Empirical research in Vietnam has focused primarily on pedagogical interventions, student perceptions, or EMI implementation challenges [12], [13]. National policy analyses [9]–[11] indicate persistent inequalities between elite and mass educational tracks, insufficient washback from standardized tests, and limited consistency between national Common European Framework of Reference for Languages (CEFR) benchmarks and university level English preparation. Despite substantial policy investment, few studies have examined proficiency differences using large scale placement datasets or quantitative modeling capable of capturing structural variation across institutional tracks.

2.5. Theoretical grounding

Communicative competence theory conceptualizes proficiency as multidimensional and context embedded [24]. Constructivist perspectives further position assessment as part of learner development rather than solely outcome measurement [5]. At the measurement level, multivariate designs provide valid interpretations of proficiency variation across demographic and instructional factors, consistent with recent validation studies in educational measurement and language testing [17]. A two-way GLM framework, therefore, allows simultaneous examination of program based and cohort-based variation.

2.6. Research gap

Despite increasing policy emphasis on EMI and bilingual STEM education, Vietnam lacks large scale empirical studies quantifying entry level English proficiency across program types with robust effect size estimation. Most previous work relies on small samples, single cohorts, or perception-based measures. This study addresses this gap by analyzing 17,561 engineering students across three institutional program structures and three consecutive cohorts, employing a two-way GLM to determine main effects and interaction patterns, thereby contributing large scale quantitative evidence relevant to policy implementation, EMI planning, and data driven curriculum decision making in Vietnam's evolving STEM landscape.

3. METHOD

3.1. Research design

This study adopted a quantitative comparative design using a two-way GLM to examine main effects and interaction effects of program type and academic year on English proficiency. The GLM approach enables simultaneous evaluation of structural variation across large heterogeneous groups and supports robust estimation under unequal sample sizes, aligning with contemporary validation research in large scale language assessment [17]. Recent methodological recommendations emphasize multivariate modelling in educational measurement to capture structural effects in complex institutional systems, particularly where EMI intersects with policy level reform [6], [22]. This design therefore allows interpretation of receptive skill variation across engineering students within a rapidly evolving EMI landscape.

3.2. Research context and participants

The research was conducted at a major Vietnamese technical university offering three institutional program tracks with varying degrees of English-medium instruction: mass (Vietnamese-medium), advanced (English-oriented), and international (English-medium jointly delivered with overseas partners). The dataset consisted of the full population of 17,561 first-year engineering students across three academic years (2022-2024): 4,212 in 2022, 6,124 in 2023, and 7,225 in 2024. All students completed the placement test during matriculation. No sampling, stratification, or exclusion was applied, enabling population level inference and avoiding sample bias commonly noted in EMI research [2], [12].

3.3. Instrument

English proficiency was measured using a standardized computer-based receptive-skill test aligned with the Test of English for International Communication (TOEIC) format [25], comprising 200 items equally divided between listening and reading (5-495 per skill; 10-990 total) [26]. Listening sections included short dialogues, extended conversations and informational monologues; reading items assessed lexical-syntactic comprehension, textual interpretation, and multi-text integration. The instrument targets academic-professional receptive competence consistent with contextual validity principles in high stakes English as a foreign language (EFL) assessment [19], [22]. Computer based delivery ensured standardized administration and automatic scoring, thereby reducing rater-based variance and supporting reliability in large scale contexts [20], [27]. Receptive placement tests were used because large scale productive assessment requires individual rating, extended administration time, and substantial scoring resources, which are rarely feasible in high volume STEM admissions contexts [19]. Consequently, Vietnamese placement policy prioritizes receptive skills as a cost-effective and scalable proxy for English academic readiness. The instrument has reported high internal consistency in comparable large-scale contexts [19].

3.4. Procedure

Testing was administered in certified digital assessment rooms using secure institutional platforms with identical instructions, timing, and auditory conditions. Trained proctors supervised all sessions. Procedures were standardized across programs and academic years, ensuring equivalence required for longitudinal institutional comparisons and eliminating procedural confounds frequently reported in placement testing research [22]. Institutional approval was granted for the educational use of anonymized administrative results.

3.5. Data preparation

Raw scores were exported directly from the testing platform without modification. Normality, variance homogeneity, and independence assumptions were examined using Shapiro-Wilk and Levene tests. Because Levene indicated heterogeneity of variances ($p < 0.001$), Welch and Brown-Forsythe corrections were applied, consistent with recommended practices for large scale educational datasets with unequal group sizes [17]. No missing data imputation or score transformation was undertaken.

3.6. Data analysis

A two-way GLM was conducted with program type (mass program (MP), advanced program (AP), international program (IP)) and academic year (2022, 2023, and 2024) as fixed factors, and listening, reading, and total scores as dependent variables. Partial eta-squared (η^2) was estimated as effect size and interpreted using established benchmarks of 0.01 (small), 0.06 (medium), and 0.14 (large) [28]. This approach allowed quantification of structural effects central to institutional program evaluation and directly informed the interpretation of effect size patterns reported in section 4. Analyses were performed using SPSS (v28) and R (v4.3).

3.7. Robustness and assumption checks

To ensure the robustness of estimation, assumption checks and supplementary diagnostics were undertaken prior to model interpretation. Normality and homogeneity of variances were examined using Shapiro-Wilk and Levene tests. Given that Levene tests indicated significant heterogeneity ($p < 0.001$), Welch and Brown-Forsythe corrections were implemented, which provide unbiased estimation under unequal group size and non-normal distributions [17], [22].

Residual plots and fitted residual diagnostics did not indicate meaningful violations of linearity or independence. Post-estimation checks confirmed stability of parameter estimates across receptive skill domains, and effect size interpretation was based on partial η^2 rather than significance testing to mitigate the influence of very large sample sizes [20], [28]. Taken together, these procedures provide reasonable confidence that structural effects reported in Section 4 are not artefacts of model misspecification or assumption violations.

3.8. Reproducibility and transparency

Analytical syntax (SPSS and R) was archived in secure institutional storage in accordance with internal data governance procedures. Data analysis followed transparent reporting guidelines for quantitative educational research [5] and did not involve automated learning analytics or machine learning-based classification.

3.9. Ethical considerations

Ethical approval was granted by the host university's review board. Data were fully anonymized before analysis and contained no personally identifiable information. Placement testing formed part of routine admission procedures, involved no intervention, and imposed minimal risk to participants, consistent with standard research ethics practice in large scale educational assessment [22].

4. RESULTS AND DISCUSSION

4.1. Descriptive statistics

Table 1 presents descriptive statistics for receptive skills across the three institutional programs. A clear proficiency hierarchy (AP > IP > MP) emerged for both listening and reading, suggesting structural advantages associated with English-medium instruction and internationally oriented curricula. Across cohorts, the overall mean total English score ($M = 432.04$, $SD = 169.51$) reflected a moderate level of receptive proficiency at university entry. Notably, AP and IP students consistently scored above 530, whereas MP students entered with substantially lower receptive readiness ($M = 415.79$). The MP-AP gap exceeded one standard deviation, indicating meaningful practical significance beyond statistical difference. Figure 2 visualizes the distribution of total English placement scores by program. The MP group shows a heavier concentration of lower scores and a wider dispersion, whereas AP and IP distributions are shifted to the right with denser clustering in higher score bands, reinforcing the descriptive hierarchy observed in Table 1.

By academic year, proficiency declined from 469.45 in 2022 to 427.96 in 2023 and 413.70 in 2024. The downward trajectory was observed across both receptive subtests, signaling progressively weaker English foundations among more recent cohorts, as in Table 2. Taken together, these descriptive trends already suggest widening receptive skill disparities across institutional tracks even before inferential testing.

Table 1. Descriptive statistics of English proficiency by program type ($N = 17,561$)

Group	N	Reading ($M \pm SD$)	Listening ($M \pm SD$)	Total ($M \pm SD$)
MP	12,450	208.12 $\pm$ 89.43	207.67 $\pm$ 87.52	415.79 $\pm$ 160.85
AP	3,250	272.38 $\pm$ 92.17	271.31 $\pm$ 93.14	543.69 $\pm$ 172.56
IP	1,861	266.08 $\pm$ 90.28	264.76 $\pm$ 88.91	530.84 $\pm$ 169.19
Total	17,561	216.02 $\pm$ 90.67	216.02 $\pm$ 89.56	432.04 $\pm$ 169.51

Note: scores based on computer-based English placement test (range=10-990).

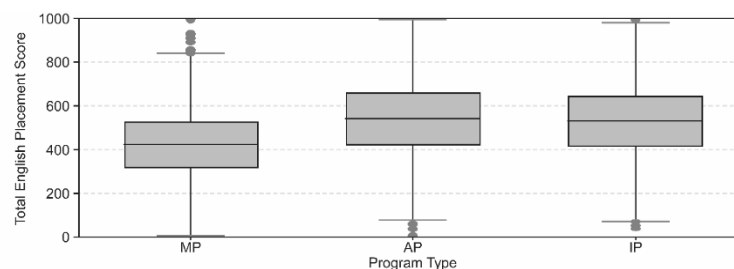


Figure 2. Distribution of total English placement scores by program type (all cohorts combined)

Table 2. Descriptive statistics of English proficiency by academic year

Academic year	N	Reading (M ± SD)	Listening (M ± SD)	Total (M ± SD)
2022	4,212	234.21 ± 88.77	235.24 ± 86.48	469.45 ± 165.37
2023	6,124	213.64 ± 89.54	214.32 ± 90.12	427.96 ± 168.44
2024	7,225	206.81 ± 91.02	206.89 ± 90.76	413.70 ± 172.05

Note: lower means across cohorts reflect declining receptive proficiency at entry.

4.2. Main effects of program type and academic year

Table 2 summarizes descriptive statistics by academic year. Mean listening, reading, and total scores all declined steadily from 2022 to 2024. The two-way GLM with program type (MP, AP, and IP) and academic year (2022, 2023, 2024) as fixed factors revealed statistically significant main effects for both predictors and their interaction (program×year), all $p < 0.001$. Program type had a substantial effect, $F = 482.17$, partial $\eta^2 = 0.21$, indicating that approximately 21% of the variance in total English proficiency was associated with institutional program structure. Following Cohen's [28] benchmarks, this constitutes a large effect, underscoring the decisive role of instructional language, curriculum format, and exposure to English-medium content in shaping receptive proficiency. Academic year also reached significance, $F = 158.63$, partial $\eta^2 = 0.09$, representing a medium effect and suggesting that macro level cohort variation (e.g., pre-university preparation, post-pandemic learning disruption, and intake profiles) exerted meaningful influence on performance over time, albeit less strongly than program level factors. These inferential results corroborate the descriptive patterns: program structure is the dominant source of variance, while cohort level shifts further depress overall proficiency.

4.3. Interaction effect

Mean listening and reading trajectories by program type are displayed in Figure 3. The two-way interaction between program type and academic year was statistically significant, $F = 37.42$, partial $\eta^2 = 0.03$, $p < 0.001$, indicating that cohort-based changes in English proficiency differed by institutional program rather than reflecting a uniform national decline.

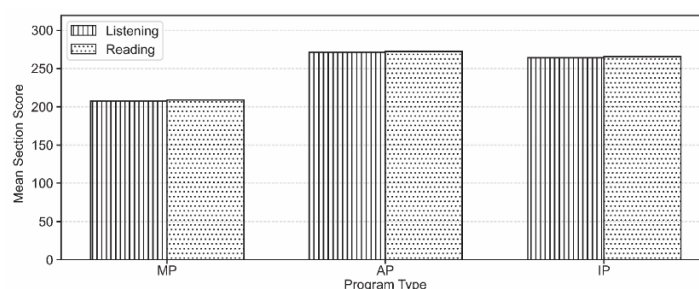


Figure 3. Mean listening and reading scores by program type (all cohorts combined)

Table 3 summarizes the main and interaction effects from the GLM model. Program type explained the largest proportion of variance, followed by academic year, with the interaction accounting for a smaller but non-trivial share. While AP and IP outcomes remained relatively stable at a high level across years, MP students exhibited a much sharper downward trend, widening the proficiency gap over time. Although smaller in magnitude than the main effects, the interaction is practically meaningful because it signals

emerging stratification in English preparedness between EMI-oriented and Vietnamese-medium programs. These interaction patterns point to cohort specific divergence, with MP students becoming increasingly disadvantaged in receptive English skills.

Table 3. Summary of two-way GLM results for English placement scores

Source	F	Sig.	Partial η^2
Program type	482.17	.000	.21
Academic year	158.63	.000	.09
Program $\times$ year	37.42	.000	.03

Note: Welch and Brown-Forsythe corrections applied due to heterogeneous variances ($p < 0.001$).

4.4. Trend interpretation

Figure 4 illustrates the interaction in total English scores across program type and academic year, and Table 4 provides the corresponding means. The most pronounced decline from 2022 to 2024 occurred within the MP group (-46.98~47 points), compared with smaller decreases in AP (-27.79 points) and IP (-32.84 points). Although AP and IP scores remained well above the MP means in all cohorts, they did not fully escape the downward trend, suggesting that broader systemic factors affect all programs but impact MP more severely. Importantly, the steeper decline in MP total scores is consistent with program specific reading and listening trajectories, implying that text processing and lecture comprehension readiness in Vietnamese-medium tracks may be increasingly misaligned with the linguistic demands of engineering curricula. Collectively, these patterns suggest that EMI-oriented environments may buffer, but not eliminate, national level declines in English preparedness, whereas traditional Vietnamese-medium programs appear increasingly insufficient to support sustained disciplinary engagement in English at university level.

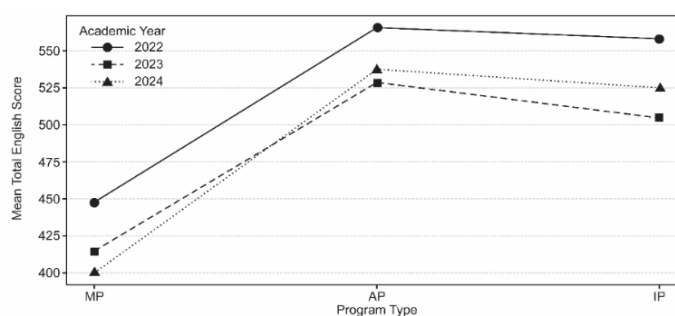


Figure 4. Interaction plot of total English scores by program type and academic year (2022-2024)

Table 4. Mean total English scores by program type and academic year (2022-2024)

Year	Program	N	Mean total
2022	MP	3408	447.50
2022	AP	459	565.94
2022	IP	345	557.96
2023	MP	5318	414.22
2023	AP	453	529.14
2023	IP	353	505.03
2024	MP	6529	400.52
2024	AP	654	538.15
2024	IP	42	525.12

4.5. Effect size interpretation

Figure 5 visualizes the relative contribution of each predictor in the GLM, highlighting the dominance of Program type in explaining variance in English proficiency. Program type exhibited the largest effect (partial $\eta^2 = 0.21$), academic year reflected a medium effect (partial $\eta^2 = 0.09$), and the interaction was comparatively smaller (partial $\eta^2 = 0.03$), although still statistically significant. Effect-size estimation thus underscores that program structure, rather than temporal fluctuation, accounted for the largest proportion of variance, confirming a strong structural component in English proficiency outcomes. At the same time, the medium effect of academic year and the smaller but significant interaction indicate that both macro level cohort dynamics (e.g., policy shifts and post-pandemic schooling) and institutional stratification jointly shape

proficiency trajectories. These quantitative patterns provide the foundation for the subsequent discussion on equity, placement policy, and curriculum realignment across engineering programs.

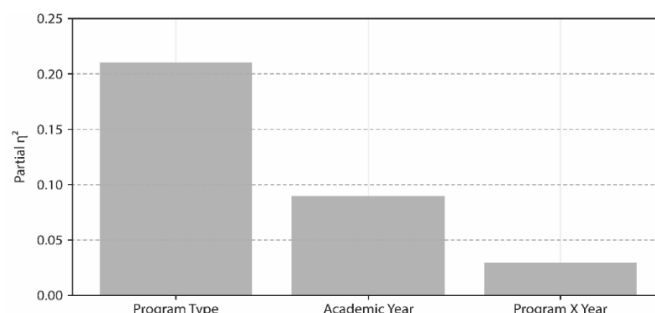


Figure 5. Partial η^2 values for predictors in the two-way GLM

4.6. Discussion

4.6.1. Institutional stratification in receptive English proficiency

The consistent AP>IP>MP ranking observed across all three cohorts demonstrates a structural pattern of receptive proficiency differentiation across program types. This pattern reinforces arguments that increased exposure to EMI contributes to enhanced access to academic language input, disciplinary discourse, and authentic communicative contexts in higher education [2], [6]. Within Vietnam, recent reviews have highlighted that engineering EMI programs are closely associated with greater academic English exposure through internationalized curricula, English-based learning materials, and EMI delivery practices [12]. From a communicative competence perspective [23], receptive skills form the foundation for constructing academic meaning, reading technical documentation, and engaging with discipline specific texts. Thus, the substantial performance gap between mass and EMI-oriented programs reported in this study suggests structural rather than purely linguistic differentiation, with implications for university level participation in technical learning [15], [29].

To better interpret the observed program level differences, it is important to consider how receptive subskills map onto core academic demands in engineering education. Listening and reading reflect different facets of engineering readiness. Listening proficiency supports lecture comprehension [30] in EMI delivery, where students must process discipline-specific explanations and instructions in real time, while reading proficiency enables engagement with technical manuals, design specifications, standards, and research texts that demand sustained interpretation of specialized written language [31]. Accordingly, program level gaps in receptive scores suggest differential access to both spoken and written disciplinary resources in engineering education.

4.6.2. Cohort-level decline and broader educational disruption

The medium-sized main effect for academic year and the steady decline from 2022 to 2024 point toward broader systemic pressures affecting national English readiness. National policy analyses have reported declining English performance and widening skill disparities following extended school disruptions during the COVID-19 period [9], [10]. These downward cohort patterns are therefore consistent with emerging evidence that Vietnamese EFL development remains uneven across secondary education levels and strongly dependent on institutional resources. Nevertheless, the larger effect of program type indicates that institutional context remains the primary determinant of English readiness, even under conditions of national decline. This finding reinforces earlier work suggesting that EMI functions as a protective factor, but only where academic English exposure is sustained and systematically embedded within disciplinary curricula [2], [6].

4.6.3. Interaction effects and emerging inequities

The statistically significant interaction showing a steeper decline for MP relative to AP and IP suggests that structural advantages in EMI programs help buffer national declines but do not fully eliminate them. This pattern signals emerging inequities in access to the linguistic foundations required for STEM participation at university. While AP and IP students maintain relatively stable performance across cohorts, MP students enter engineering with increasingly insufficient receptive readiness, likely limiting their participation in academic reading, technical documentation, and English-mediated coursework [15], [29]. These trajectories raise concerns regarding equitable access to disciplinary English in engineering education, particularly given the increasing reliance on English-medium scientific materials, international accreditation frameworks, and technology-based pedagogies across Vietnamese universities [9], [10]

4.6.4. Implications for EMI policy and program architecture

The institutional differentiation identified here has implications for Vietnam's ongoing efforts to expand EMI in STEM to meet national goals in innovation and digital transformation [9], [10]. Program structures that concentrate English exposure within advanced or international tracks risk replicating advantage for selected student populations while leaving large cohorts without sufficient linguistic preparation for disciplinary study. This raises questions about equitable placement, differential resource allocation, and the sustainability of EMI expansion if mass program students continue to enter STEM curricula with significantly lower receptive proficiency. The results therefore support calls for targeted language support within Vietnamese-medium programs and greater curricular integration of receptive skill development within engineering pathways [12], [13].

4.6.5. Placement testing and data-driven program alignment

International research suggests that English placement systems can inform curricular design, improve learner streaming, and predict academic performance [19], [20]. However, while placement testing in the present study successfully distinguished program-based differences, the persistence of low MP performance indicates that testing alone is insufficient without program-level interventions. Policy and curriculum developers may therefore consider complementary strategies, including structured academic reading support, EMI bridging courses, discipline integrated receptive skill modules, bilingual lecture support, and targeted learning analytics based on placement data. Such initiatives could mitigate inequalities at program entry and strengthen the linguistic foundations required for academic participation in engineering.

4.6.6. Theoretical and empirical contribution

The present findings contribute to EMI and STEM language education by providing large scale empirical evidence of structural and cohort effects on English proficiency in Vietnamese higher education. Previous studies have typically relied on small samples, perception-based methods, or single institutions. By contrast, this population level dataset demonstrates strong structural effects (partial $\eta^2=0.21$) alongside emerging cohort declines, offering quantitative evidence that complements existing qualitative research on Vietnamese EMI challenges [12], [13]. Methodologically, the use of two-way GLM with effect size interpretation and robustness checks extends current empirical approaches in Vietnamese EFL assessment, offering a scalable framework for monitoring language readiness across institutional pathways.

Taken together, the results suggest that English proficiency in engineering education in Vietnam is shaped primarily by program structure and secondarily by macro level cohort dynamics. Structural variation across institutional pathways therefore represents both a barrier and an opportunity: EMI exposure can buffer systemic decline, but only for students with access to EMI conditions. Without expanded support for Mass Program students, widening disparities could undermine national goals in STEM modernization, internationalization, and digital transformation.

4.7. Implications and limitations

Several implications follow, practically, universities should employ placement data not only for level sorting but as evidence for differentiated curricula and targeted receptive skill support, especially for mass students. Theoretically, the findings contribute to current EMI scholarship by demonstrating structural variation of receptive competence at large institutional scale. Policy-wise, the results highlight the importance of dedicating resources to Vietnamese-medium programs to avoid widening inequity as EMI expands nationally.

The study is subject to several limitations, including its single institution focus and emphasis on receptive placement scores rather than productive skills or subsequent academic achievement. Although the present study provides robust evidence of program level and cohort level variation in receptive English proficiency, the analysis was necessarily conducted at the aggregate skill level (listening, reading, and total) due to the structure of the available administrative datasets. Future research should incorporate multi-institutional datasets, longitudinal tracking, and multilevel analyses linking English placement to disciplinary performance, retention, and career outcomes. In addition, qualitative inquiry into students' learning trajectories could further illuminate the mechanisms underlying the observed disparities. Generalization of the present findings thus remains tentative, underscoring the need for replication across institutional contexts. Future research could extend the present findings by examining item-level performance or finer-grained subskills (e.g., lecture comprehension, inferencing, and technical vocabulary processing) to identify whether specific question types disproportionately contribute to program level differences. Such analyses would allow more diagnostic interpretations of strengths and weaknesses across institutional tracks and support targeted instructional interventions.

Despite these limitations, the study provides the largest population level evidence to date on English proficiency variation across engineering program types in Vietnam. By showing how structural differences

translate into measurable receptive outcomes, the findings support national efforts to internationalize engineering education and provide a basis for data driven policy design and targeted EMI implementation. The study thus achieves what was outlined in the Introduction: offering empirical evidence capable of informing curriculum reform, placement policy, and equitable access to English-medium STEM education, while suggesting meaningful directions for future development and research application.

5. CONCLUSION

This study set out to examine whether institutional program structures: mass, advanced, and international, shape entry level receptive English proficiency among Vietnamese engineering students, as hypothesized in the Introduction. The results provide clear empirical confirmation: program type exerted the largest effect on listening and reading performance, followed by cohort differences, with a significant program×year interaction. These findings indicate that what is expected theoretically, that English-medium conditions provide greater exposure, academic engagement, and disciplinary access, does translate into measurable differences in proficiency outcomes.

Taken together, the results and discussion sections demonstrate that EMI oriented tracks (AP and IP) maintain substantially higher receptive readiness over time, while Vietnamese-medium pathways experience both lower absolute performance and steeper decline. This pattern reinforces theoretical perspectives that emphasize contextual language exposure and disciplinary literacy as central to academic English development in STEM. At the same time, medium-sized cohort declines reveal broader systemic pressures affecting all groups, partially supporting national concerns about English readiness for engineering education and innovation driven development.

FUNDING INFORMATION

Thanks to the support from the Center for Foreign Language Assessment and Cultural Exchange, Hanoi University of Science and Technology, Vietnam (Grant No. CLCE5), this article was made possible.

AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

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Phuong Anh Ngo	✓	✓			✓	✓			✓	✓				

C : **C**onceptualization

M : **M**ethodology

So : **S**oftware

Va : **V**alidation

Fo : **F**ormal analysis

I : **I**nvestigation

R : **R**esources

D : **D**ata Curation

O : Writing - **O**riginal Draft

E : Writing - Review & **E**diting

Vi : **V**isualization

Su : **S**upervision

P : **P**roject administration

Fu : **F**unding acquisition

CONFLICT OF INTEREST STATEMENT

The author declares no conflict of interest.

INFORMED CONSENT

Informed consent was obtained from all participants included in this study prior to administration.

DATA AVAILABILITY

All data supporting the findings of this study are included within the article. Additional data may be made available by the corresponding author, [PAN], upon reasonable request and with institutional approval.

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