

The Role of Technology Competence in the Relationship Between Language Proficiency and Mathematical Competence

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Abstract. Despite the recognized importance of language proficiency and technology competence in STEM education, limited research has examined how technology competence explains or influences the relationship between language proficiency and mathematical competence among engineering students. Thus, this study aimed to determine the influence of language proficiency on mathematical competence and examine the role of technology competence in explaining and shaping this relationship among selected engineering students. Using a quantitative research design, the study involved 65 first-year engineering students from a private university in Northern Mindanao, Philippines, selected through stratified random sampling. Data were collected using an adapted validated questionnaire and analyzed through regression-based mediation and moderation analyses. Findings revealed that language proficiency significantly influenced mathematical competence with strong explanatory power. Technology competence also significantly mediated the relationship between language proficiency and mathematical competence, indicating that part of the influence of language proficiency operates through students' technology competence. However, technology competence did not significantly moderate the relationship, suggesting that the influence of language proficiency on mathematical competence remains consistent regardless of students' level of technology competence. These findings highlight the complementary roles of language and technology competencies in strengthening mathematical learning and suggest that educational institutions should adopt integrated instructional strategies that simultaneously develop communication, technological, and mathematical competencies to better prepare students for the demands of STEM education.

Keywords: Mathematics Education; Engineering Education; Mediation Analysis; Moderation Analysis; Digital Competence

Introduction

Mathematical competence is one of the most critical indicators of students' readiness for participation in science, technology, engineering, and mathematics (STEM) fields, which are widely recognized as essential drivers of innovation and economic development in the 21st century. Globally, educational systems continue to face persistent challenges in improving students' mathematical performance despite various curriculum reforms and instructional innovations. International standardized assessments, such as Programme for International Student Assessment (PISA), consistently highlight the need to strengthen foundational competencies such as mathematical reasoning, problem-solving, and quantitative literacy to prepare students for complex technological environments and future careers (UNESCO, 2017; OECD, 2019). Thus, mathematical competence remains a central educational concern because it reflects not only students' cognitive abilities but also their preparedness for lifelong learning and participation in knowledge-based societies.

In recent years, scholars have increasingly recognized that mathematical competence does not develop separately from other competencies but is shaped by a combination of cognitive, linguistic, and technological factors. Among these, language proficiency has been identified as a critical element because mathematical understanding often depends on students' ability to comprehend problem statements, interpret symbolic representations, and communicate solutions effectively. Research in STEM education demonstrates that language competence is closely linked with mathematical learning outcomes, particularly in problem-solving and conceptual understanding, where comprehension of academic language plays a crucial role (Duo-Terron et al., 2022).

At the same time, the rapid advancement of digital technologies has transformed the educational landscape, making technology competence another important factor shaping students' academic performance. Digital competence is now widely regarded as a core 21st-century skill necessary for effective learning, particularly in higher education environments where technology is increasingly integrated into instruction, assessment, and collaboration. A growing body of research suggests that students' technological competencies influence their academic engagement, problem-solving ability, and learning outcomes, especially in STEM-related disciplines (Zhao et al., 2021; Koyuncuoğlu, 2022). Moreover, evidence from large-scale educational datasets indicates that students' use of digital resources and ICT skills is associated with variations in mathematics and literacy performance, suggesting that technological competence plays an important role in shaping academic achievement.

Although previous studies have established the individual importance of language proficiency, technology competence, and mathematical competence in supporting students' academic achievement, these variables have largely been investigated independently or through direct predictive relationships (Duo-Terron et al., 2022; Tzafilkou et al., 2022; Zhao et al., 2021). Recent studies have likewise demonstrated that language proficiency significantly contributes to mathematical learning (Bernardo et al., 2021; OECD, 2023), while technology competence has been identified as an important predictor or mediator of various educational outcomes (Mehrvarz et al., 2021; Zakir et al., 2025). However, empirical evidence simultaneously examining whether technology competence functions as both a mediating and moderating mechanism in the relationship between language proficiency and mathematical competence remains limited, particularly among engineering students in higher education and in developing-country contexts (Barodi et al., 2026; Hayes, 2022). Addressing this gap may provide a more comprehensive understanding of how language and technological competencies collectively contribute to the development of students' mathematical competence.

In the Philippine context, improving mathematical competence remains a continuing educational priority due to persistent concerns about students' performance in mathematics and STEM-related courses. Results from PISA 2022 continue to show that Filipino students perform below the global average in mathematics, highlighting ongoing challenges in developing the foundational competencies necessary for success in higher education and technical fields (OECD, 2023). These findings emphasize the need for stronger preparation in critical academic competencies that support STEM readiness. Supporting this concern, local empirical studies have likewise demonstrated the importance of strengthening higher-order mathematical skills among Filipino learners. For instance, Asahid and Lomibao (2020) found that instructional approaches integrating real-world mathematical applications and proof-writing activities significantly improve students' problem-solving, reasoning, and creative mathematical thinking, which are essential dimensions of mathematical competence. Similarly, Cano and Lomibao (2023) reported that exposure to phenomenon-based learning videos significantly enhanced students' problem-solving skills, reasoning abilities, and mathematics self-efficacy, competencies closely associated with the development of mathematical competence in tertiary education. Given the increasing integration of digital technologies and technical communication in engineering education, preparing students in mathematics alone is no longer sufficient. Equally important is the development of language proficiency and technology competence, as these competencies collectively support students' success in technology-driven learning environments. Understanding how these competencies interact may therefore provide valuable insights for designing instructional strategies that promote holistic student development in STEM education.

In response to the identified research gap, this study aimed to determine the influence of language proficiency on mathematical competence and examine whether technology competence serves as a mediating and moderating variable in the relationship between language proficiency and mathematical competence among first-year engineering students. Specifically, the study sought to determine whether technology competence explains how language proficiency influences mathematical competence and whether it alters the strength of this relationship. The study was delimited to first-year engineering students enrolled in a private university in Northern Mindanao, Philippines. This population was selected because engineering education requires the integration of language, technological, and mathematical competencies to support success in STEM learning. Accordingly, the findings should be interpreted within the context of this institutional setting and student population and may not be directly generalizable to other disciplines, educational levels, or institutional contexts.

Research Questions

1. Does language proficiency significantly influence mathematical competence?
2. Does technology competence significantly mediate the influence of language proficiency on mathematical competence?
3. Does technology competence significantly moderate the influence of language proficiency on mathematical competence?

Literature Review

This study is anchored on the Cognitive Theory of Multimedia Learning (CTML) of Mayer (2020), which explains that meaningful learning occurs when learners actively select, organize, and integrate verbal and visual representations during cognitive processing. In mathematics and other STEM disciplines, this perspective is particularly relevant because learning requires students to connect linguistic information with symbolic, graphical, numerical, and increasingly technology-mediated representations. Language proficiency therefore provides an important foundation for understanding instructions, technical terminology, and problem situations, whereas technology competence may enable students to access, interpret, and manipulate digital representations that support mathematical reasoning. Studies in higher education generally support the complementary contribution of linguistic and digital competencies to learning outcomes (Zhao et al., 2021; Tzafilkou et al., 2022), while Philippine studies similarly indicate the importance of technological readiness in supporting engagement and performance in technology-mediated learning environments (Toquero, 2020; Rotas & Cahapay, 2020). Taken together, these perspectives suggest that language and technology competencies should not be viewed merely as independent predictors of mathematical learning but as potentially interconnected resources within the learning process.

Language Proficiency and Mathematical Competence

The literature demonstrates considerable agreement that mathematical competence depends on more than computational knowledge. Successful mathematical reasoning also requires learners to comprehend problem statements, interpret relationships among representations, and communicate their reasoning accurately. Duo-Terron et al. (2022) associated linguistic competence with mathematical reasoning and problem-solving, while Philippine evidence similarly points to the contribution of reading comprehension and communication-related skills to academic performance (Bernardo et al., 2021; Department of Education, 2022). These findings are consistent with the broader argument that language facilitates students' understanding of technical terminology, quantitative information, and the logical structure of mathematical problems (Mayer, 2020; OECD, 2023). Although these studies converge on the importance of language in quantitative learning, they differ in the specific outcomes and contexts examined. Duo-Terron et al. (2022), for instance, considered linguistic and mathematical competence within STEAM education, whereas Bernardo et al. (2021) focused more directly on factors associated with English reading proficiency among Filipino learners. Thus, the collective literature supports a connection between linguistic capacity and mathematical learning, but the evidence is distributed across different learner populations, constructs, and educational settings. More importantly, demonstrating that language proficiency predicts mathematical competence does not fully explain how this relationship develops in contemporary learning environments where mathematical instruction increasingly involves digital platforms, simulations, computational applications, and online resources. This distinction creates a conceptual basis for examining technology competence as part of the mechanism linking language proficiency with mathematical competence.

Technology Competence as a Mediating Mechanism

The theoretical rationale for mediation rests on the possibility that language proficiency facilitates students' effective engagement with technology-mediated learning, which in turn contributes to mathematical competence. Under CTML, learners must comprehend verbal information before effectively integrating it with visual, symbolic, and technology-supported representations. Students with stronger language proficiency may therefore be better equipped to understand digital instructions, interpret information presented through technological platforms, and navigate technology-based learning resources. Greater capacity to use these resources may subsequently enhance mathematical understanding and problem-solving. In this sense, technology competence may function as an explanatory pathway through which part of the contribution of language proficiency is transmitted to mathematical competence. Existing empirical findings provide indirect support for this mechanism, although they have examined somewhat different relationships. Mehrvarz et al. (2021) demonstrated that digital competence was connected with academic performance through digital informal learning, while Heidari et al. (2021) similarly showed that digital competence operated through technology-related learning processes in relation to academic engagement. Hidayat-Ur-Rehman (2024) further found that formal digital learning, smartphone utilization, and perceived autonomy helped explain the association between digital competence and student engagement. Zakir et al. (2025), in contrast, positioned digital competence itself as a mediator between digital literacy and academic achievement. Despite differences in how digital competence was positioned within their respective models, these studies converge on an important point: technology-related competence often operates within a chain of learning processes rather than functioning only as an isolated predictor of academic outcomes.

At the same time, these studies cannot be treated as direct confirmation of the proposed mediation in the present study. Their antecedent and outcome variables differ from language proficiency and mathematical competence, and several examine engagement or general academic performance rather than mathematics-specific outcomes. Consequently, they provide a conceptual and empirical basis for expecting an indirect pathway but do not establish that language proficiency enhances mathematical competence specifically through technology competence. This distinction provides the justification for testing technology competence as a mediator rather than assuming its mediating role from findings obtained with different constructs.

Technology Competence as a Moderating Condition

Technology competence may also operate differently - as a moderating condition rather than as a transmission mechanism. Conceptually, mediation and moderation address different questions. A mediating role would indicate that language proficiency contributes to mathematical competence partly through students' technology competence, whereas a moderating role would indicate that the strength of the language-mathematics relationship depends on the level of technology competence (Hayes, 2022; Igartua & Hayes, 2021). Thus, testing both roles does not imply that the two mechanisms are interchangeable; rather, it examines two theoretically distinct ways in which technology competence may participate in mathematical learning. A moderating effect is plausible in technology-rich STEM environments because students with different levels of technology competence may not benefit equally from their language proficiency. Students with stronger technological skills may be better able to convert their comprehension of verbal or written mathematical information into effective use of simulations, computational applications, digital representations, and online problem-solving resources. Under such conditions, technology competence could strengthen the extent to which language proficiency translates into mathematical understanding. Conversely, if students possess limited technological competence, strong language proficiency may still support mathematical learning, but its contribution through digitally mediated tasks may be constrained. From a CTML perspective, this possibility follows from the importance of effectively integrating verbal information with multiple representations; however, CTML does not itself establish that technology competence must moderate the relationship. Rather, it provides a theoretical reason to investigate whether differences in students' capacity to handle technology-mediated representations alter the contribution of language proficiency to mathematical competence. The empirical literature provides less direct support for this conditional role than for the mediating role. Research has more commonly treated digital or technology competence as a predictor or as part of an indirect learning process. Zhao et al. (2024), for example, illustrated that variables in educational models can perform distinct functions, with self-efficacy operating as a mediator while gender served as a moderator. Although this study did not establish technology competence as a moderator of language-related learning, it demonstrates the broader principle that a variable contributing to educational outcomes does not necessarily operate through the same mechanism across models. Hayes (2022) likewise emphasizes that a variable may have a significant direct association with an outcome without significantly changing the strength of another relationship. This distinction makes the moderating role of technology competence an empirical question requiring direct examination, rather than an effect that can be inferred merely from its positive association with academic performance.

Methodology

Research Design

This study employed a quantitative research design to examine the relationship between language proficiency and mathematical competence and to determine whether technology competence functions as a mediating and moderating variable in this relationship. The design was appropriate because the study sought to estimate the predictive contribution of language proficiency to mathematical competence and examine both indirect and conditional effects without manipulating the variables. Regression-based mediation and moderation analyses were employed to determine how technology competence may explain or alter the relationship between the predictor and outcome variables (Hayes, 2022; Igartua & Hayes, 2021).

Sampling Design

The study employed stratified random sampling to ensure proportional representation of first-year engineering students across four sections. The sampling frame consisted of 110 officially enrolled first-year engineering students during the second semester of academic year 2025–2026, based on official class lists obtained from the academic office. A sample of 65 students was determined using the Select Statistical Services online sample size calculator for a population mean at a 95% confidence level and 5% margin of error. The sample was proportionately allocated across the four sections, ensuring that every eligible student within each stratum had an equal chance of selection (Cano et al., 2026; Makwana et al., 2023). The adequacy of the sample for regression-based mediation and moderation analyses was further considered in

relation to model stability and measurement reliability (Hayes, 2022; Hair et al., 2021).

Research Locale

The study was conducted at a private autonomous university in Northern Mindanao, Philippines, recognized by the Commission on Higher Education (CHED) and offering programs across basic, tertiary, and graduate education. The institution serves a diverse student population and offers engineering programs that integrate mathematics, technical communication, and technology-supported learning. The university was selected because its engineering curriculum provides an appropriate setting for examining the relationship among language proficiency, technology competence, and mathematical competence, particularly among first-year engineering students who regularly engage in mathematics-intensive and technology-mediated learning activities.

Research Participants

The participants were 65 first-year engineering students enrolled in four sections at the participating university. Students were eligible to participate if they were (a) officially enrolled as first-year engineering students during the period of data collection, (b) members of any of the four sections included in the sampling frame, (c) present during the scheduled administration of the questionnaire, and (d) willing to participate after providing informed consent. Students were excluded if they were not officially enrolled in the identified sections, had withdrawn or dropped from enrollment before data collection, or declined participation. Participation was entirely voluntary, and no academic incentive or penalty was associated with participation.

Research Instrument

Data were collected using an adapted 5-point Likert scale questionnaire (Barodi et al., 2026). The instrument consisted of 54 items equally distributed across three variables: language proficiency, technology competence, and mathematical competence (18 items each), with three dimensions and six items per dimension. The dimensions were reading, writing, and speaking for language proficiency; fundamental computer knowledge, internet use, and digital problem-solving for technology competence; and problem-solving, calculation accuracy, and application skills for mathematical competence. The instrument was contextualized to the engineering learning environment while preserving its original constructs and underwent expert validation by two doctoral degree holders specializing in mathematics education and educational psychology, who evaluated its clarity, relevance, construct alignment, and contextual appropriateness. Their recommendations were incorporated prior to the final administration (Ocaya, 2026). Moreover, a pilot test was conducted to 30 first-year engineering students who were not part of the actual respondents. The variables obtained acceptable Cronbach's alpha values of 0.78, 0.71, and 0.82, respectively (Cano & Lomibao, 2022).

Data Gathering Procedure

Data collection commenced after securing approval from the appropriate authorities. Official class lists were used as the sampling frame for stratified random sampling, after which selected students were informed of the study's objectives and ethical considerations before providing written informed consent. The questionnaires were administered face-to-face during January of 2026 and required approximately 10-15 minutes to complete. Only completed questionnaires were included in the analysis. Participant anonymity and confidentiality were maintained by assigning numerical codes and reporting the results without identifying any participant. Standard ethical principles of voluntary participation, informed consent, confidentiality, and responsible data handling were strictly observed throughout the study.

Results and Discussions

The study of Barodi et al. (2026) showed that the respondents' levels of language proficiency, technology competence, and mathematical competence are all at High Level, and when combined together in a regression model, both language proficiency and technology competence significantly predict mathematical competence. This finding suggests that engineering students who possess stronger communication abilities and higher technological skills are more likely to demonstrate better mathematical understanding and performance. It further implies that both language-related competencies and technological preparedness serve as important academic foundations that support the development of mathematical competence among engineering students.

The Influence of Language Competence

In Table 1, the influence of language proficiency on mathematical competence was examined with language proficiency as the sole predictor. The regression model was statistically significant and demonstrated strong explanatory power, indicating that language proficiency accounts for a substantial proportion of the variation in students' mathematical competence. This finding establishes language proficiency as an important predictor of mathematical competence among the engineering students.

Table 1. Regression Analysis in the Influence of Language Proficiency on Mathematical Competence

Predictor	Unstandardized Coefficients (B)	Standardized Coefficients (β)	t-value	p-value	Decision	Interpretation
(Constant)	1.060	-----	2.900	0.005	----	-----
Language Proficiency	0.691	0.697	7.708	<0.001	Reject H ₀₁	Significant
Model Summary: $R^2 = 0.485$; $F\text{-value} = 59.418$; $p\text{-value} < 0.001$; Interpretation = Significant						

The regression analysis indicates that language proficiency significantly and positively influences mathematical competence, leading to the rejection of H₀₁. Students with higher language proficiency tend to demonstrate greater mathematical competence, suggesting that stronger communication and comprehension skills contribute meaningfully to mathematical learning. Based on this relationship, the following regression equation provides a quantitative representation of the predictive contribution of language proficiency to mathematical competence. The regression equation model is established as:

$$Y = 1.060 + 0.691X + \varepsilon$$

where Y represents mathematical competence, X represents language proficiency, and ε is the error term. The regression equation indicates a positive predictive relationship between language proficiency and mathematical competence. As language proficiency increases, mathematical competence is likewise expected to improve, while the error term represents the contribution of other factors not included in the model. Thus, the equation reinforces the predictive importance of language proficiency while recognizing that mathematical competence may also be shaped by variables beyond those examined in the study.

The finding may be understood through the Cognitive Theory of Multimedia Learning of Mayer (2020), which emphasizes learners' capacity to process and integrate verbal and symbolic information. Among first-year engineering students, this mechanism is particularly relevant because mathematical learning requires simultaneous engagement with written problem statements, technical terminology, equations, symbols, diagrams, and other representations. Students with stronger language proficiency may therefore have an advantage not simply because they communicate better, but because they can more accurately extract relevant information from mathematically expressed problems and connect it with appropriate symbolic and quantitative representations. As students transition into engineering education, where mathematical tasks become increasingly technical and discipline-oriented, limitations in language comprehension may consequently create an additional cognitive burden that interferes with mathematical reasoning.

Additionally, the finding is consistent with the broader evidence that linguistic competence contributes to mathematical reasoning and problem-solving (Duo-Terron et al., 2022) and that comprehension-related competencies are important among Filipino learners (Bernardo et al., 2021). However, the present finding extends this relationship to first-year engineering students, for whom language and mathematics are encountered within a more specialized academic environment. At this stage, students are transitioning from general secondary mathematics to engineering-oriented quantitative tasks in which problems may contain technical vocabulary, multistep instructions, and discipline-specific contexts. Language proficiency may therefore function as a cognitive access skill: students who understand the linguistic structure of a problem more accurately can devote greater cognitive resources to identifying mathematical relationships and selecting appropriate solution procedures rather than first struggling to interpret what the problem requires.

Furthermore, the strong explanatory contribution of language proficiency further suggests that mathematical competence among these students cannot be viewed as exclusively numerical or computational. This may be especially important in first-year engineering education, where students must adjust to more complex mathematical content while simultaneously learning the technical discourse through which engineering problems are presented. Although previous literature recognizes language as important in quantitative learning (Mayer, 2020; OECD, 2023), the present result suggests that its contribution may become particularly consequential during this transition period. In the Philippine higher education context, where students may enter university with varying levels of preparation in academic English and mathematics, differences in language proficiency may influence how effectively they access mathematically demanding instruction. Strengthening mathematical competence may therefore require attention not only to

computational skills but also to students' comprehension of technical language and their ability to interpret quantitatively expressed information.

The Mediating Effect of Technology Competence

Table 2 presents the mediation analysis examining whether technology competence mediates the influence of language proficiency on mathematical competence. The indirect effect was statistically significant, leading to the rejection of H_{02} and indicating that technology competence serves as a significant mediator. At the same time, the direct effect of language proficiency remained significant after accounting for technology competence. Approximately half of the overall influence was transmitted through technology competence, indicating substantial partial mediation. Thus, language proficiency contributes to mathematical competence both directly and indirectly through students' technology competence.

Table 2. Mediation Analysis of Technology Competence in the Influence of Language Proficiency on Mathematical Competence

Effect	B	SE	z	p-value	Decision	Interpretation
Indirect Effect (a × b)	0.346	0.089	3.87	<0.001	Reject H_{02}	Significant
Direct Effect (c) LP → MC	0.345	0.111	3.12	0.002	-----	Significant
Total Effect (c + a × b)	0.691	0.088	7.83	<0.001	-----	Significant
LP → TC (a)	0.735	0.089	8.20	<0.001	-----	Significant
TC → MC (b)	0.470	0.107	4.38	<0.001	-----	Significant

Note: LP – Language Proficiency; MC – Mathematical Competence; TC – Technology Competence; 50% - Percent of Partial Mediation

This finding implies that improving students' mathematical competence may require not only strengthening their language proficiency but also enhancing their technology competence, as both serve as important pathways through which mathematical competence develops. This suggests that higher education institutions, particularly those offering engineering programs, may benefit from integrating language development activities and technology-supported learning strategies within mathematics instruction. By doing so, institutions can support both the direct contribution of language skills to mathematical understanding and the indirect contribution facilitated through students' ability to effectively utilize technological tools for learning, problem-solving, and information processing.

The significant total effect further demonstrates the overall contribution of language proficiency to mathematical competence when both the direct and indirect pathways are considered. Students with stronger language proficiency tend to demonstrate better mathematical competence, reinforcing the role of language as a foundational academic skill for understanding mathematical concepts, interpreting problem statements, and communicating solutions effectively.

Examination of the mediation pathways shows that language proficiency significantly predicts technology competence, suggesting that students with stronger language skills may be better equipped to understand digital instructions, navigate technological platforms, and engage with technology-mediated learning resources. Technology competence, in turn, significantly predicts mathematical competence, indicating that students' ability to effectively utilize digital learning platforms, computational applications, and online resources may support their mathematical problem-solving and conceptual understanding.

The mediating effect of technology competence provides a more specific explanation of how language proficiency may contribute to mathematical competence. From the perspective of CTML (Mayer, 2020), language proficiency may help students understand instructions and information presented through digital learning environments, while technology competence enables them to act on that understanding by navigating platforms, accessing resources, and using computational or digital tools. For first-year engineering students, these competencies may operate sequentially: comprehending technology-mediated mathematical information is necessary, but students must also possess sufficient technological competence to manipulate, explore, or apply that information effectively. Technology competence therefore appears to serve as a functional bridge between understanding mathematically relevant information and using that information in technology-supported problem-solving.

Previous studies have similarly positioned digital competence within indirect pathways to academic outcomes (Mehrvarz et al., 2021; Zakir et al., 2025), but the present finding identifies a different and more context-specific pathway involving language and mathematical competence. Among first-year engineering students, understanding digital instructions, searching for relevant information, interpreting technology-generated representations, and using computational resources may all depend partly on the students' capacity to process academic and technical language. Stronger language proficiency may consequently make technology-supported learning resources more accessible and usable, while technology competence allows

that linguistic understanding to be translated into mathematical activity. This mechanism is particularly relevant in engineering education because mathematical learning increasingly occurs through a combination of textual, symbolic, graphical, and digital representations rather than through computation alone.

The partial nature of the mediation is theoretically important because it indicates that technology competence explains only part of the relationship between language proficiency and mathematical competence. Language proficiency therefore appears to contribute to mathematical learning through at least two routes: directly, by facilitating comprehension and reasoning, and indirectly, by enabling students to engage more effectively with technology-supported learning. This interpretation is compatible with evidence that digital competence operates through learning processes rather than merely as an isolated predictor of academic outcomes (Heidari et al., 2021; Hidayat-Ur-Rehman, 2024). In the present engineering context, the coexistence of these pathways suggests that technology does not replace the foundational role of language; instead, it provides an additional means through which linguistic competence can be converted into productive mathematical learning. This distinction is important for instruction because improving access to digital tools alone may be insufficient when students have difficulty comprehending the technical and mathematical information those tools are intended to support.

The Moderating Effect of Technology Competence

Table 3 presents the moderation analysis examining whether technology competence moderates the influence of language proficiency on mathematical competence. Both language proficiency and technology competence demonstrated significant positive main effects on mathematical competence, indicating that each contributes independently to students' mathematical competence. However, their interaction was not statistically significant; therefore, H_{03} was not rejected. This indicates that technology competence does not significantly alter the strength of the relationship between language proficiency and mathematical competence.

Table 3. Moderation Analysis of Technology Competence in the Influence of Language Proficiency on Mathematical Competence

Variables	B	SE	z	p-value	Decision	Interpretation
Language Proficiency (LP)	0.383	0.084	4.57	<0.001	---	Significant
Technology Competence (TC)	0.512	0.073	6.99	<0.001	---	Significant
Interaction Term (LP x TC)	0.201	0.106	1.89	0.058	Do not reject H_{03}	Not significant
Average Simple Slope	0.383	0.085	4.53	<0.001	---	Significant
Low (-1SD)	0.296	0.077	3.83	<0.001	---	Significant
High (+1SD)	0.471	0.113	4.17	<0.001	---	Significant

Further examination of the simple slopes shows that language proficiency remains a significant predictor of mathematical competence across low, average, and high levels of technology competence. This consistency supports the absence of a significant moderating effect: although technology competence contributes independently to mathematical competence, it does not substantially change the contribution of language proficiency. Thus, language proficiency remains an important predictor of mathematical competence across varying levels of students' technology competence.

The absence of a significant moderating effect is noteworthy because technology competence independently contributes to mathematical competence but does not substantially change the strength of the contribution of language proficiency. As Hayes (2022) explains, a variable may contribute to an outcome without necessarily serving as a condition under which another relationship becomes stronger or weaker. In the present context, this suggests that language proficiency performs a relatively stable foundational role in mathematical learning among first-year engineering students. Whether students possess comparatively lower or higher technology competence, they still need to comprehend problem statements, interpret technical terminology, organize information, and understand mathematical relationships. Technology competence may enhance what students can do with mathematical information, but it does not appear to compensate for or substantially amplify the linguistic processes required to understand that information in the first place.

The consistency of the relationship across different levels of technology competence further suggests that language proficiency operates as a broadly applicable academic resource rather than one whose value depends on students' technological skill. This pattern is compatible with the view that digital competence

often provides direct academic support rather than necessarily changing relationships among other academic competencies (Zhao et al., 2021). For first-year engineering students, mathematical tasks continue to require linguistic comprehension even when technology is available because digital platforms, computational applications, and online resources still present information through instructions, symbols, labels, explanations, and problem contexts that must be understood before they can be used effectively. Thus, greater technology competence may expand students' capacity to engage with mathematical resources, but it does not eliminate the underlying need for language proficiency.

Ethical Considerations

The study was conducted as classroom-based academic research involving engineering students enrolled in classes handled by the researcher. In accordance with the college research ethics policy, permission to conduct the study was secured from the Dean of the College of Engineering prior to data collection. Participation was entirely voluntary, and students were informed of the purpose of the study and assured that their decision to participate or decline would have no effect on their grades or academic standing. Written informed consent was obtained, and anonymity, confidentiality, and responsible handling of data were strictly observed throughout the study. No personally identifiable information was reported, and the data collected were used solely for research purposes.

Conclusion

This study demonstrates that language proficiency and technology competence play distinct but complementary roles in the mathematical competence of first-year engineering students. More importantly, the simultaneous examination of technology competence as both a mediator and moderator provides a deeper understanding of how these competencies operate together. Technology competence functions as a significant pathway through which language proficiency contributes to mathematical competence, but it does not significantly alter the strength of this relationship. This distinction extends existing knowledge by showing that technology competence appears to operate more as an explanatory mechanism than as a conditional factor in the language-mathematics relationship. In practical terms, the findings denote that strengthening technology competence can complement, rather than substitute for, the foundational role of language proficiency in mathematics learning. The findings should nevertheless be interpreted within the scope of the study. The participants were drawn from a single private university and involved a relatively small sample of first-year engineering students; hence, the findings may not be generalized to other institutions, disciplines, or student populations without further evidence. Moreover, the cross-sectional design should be considered when interpreting the predictive influence and relationships observed among the variables. Future studies may examine these relationships using larger and more diverse samples across multiple institutions and employ longitudinal or other research designs that can provide stronger evidence regarding how language proficiency, technology competence, and mathematical competence develop and interact over time.

Recommendations

Higher education institutions, particularly those offering engineering and STEM-related programs, may strengthen mathematics instruction by integrating language-support and technology-assisted learning strategies. These may include explicit instruction in mathematical and technical vocabulary, guided interpretation of word problems, structured explanation of mathematical reasoning, and the use of interactive simulations, computational applications, digital problem-solving activities, and learning platforms that allow students to connect verbal, symbolic, and graphical representations. Such strategies may help students use their language and technology competencies more effectively in understanding and solving mathematical problems. Future research may validate the mediation model across different institutions, academic programs, and educational contexts and examine other explanatory variables that may account for the relationship between language proficiency and mathematical competence. Longitudinal and experimental studies may also be conducted to further examine how these competencies develop and interact over time and under specific instructional interventions.

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