International Journal of Educational Qualitative Quantitative Research (IJE-QQR)
ISSN: 2962-9918 (Online)
Vol. 4, No. 2, pp. 1-14

Technology-Driven Interaction and English Language Learning Outcomes: The Mediating Effects of Engagement and Motivation

Turab Hussain[1], Eka Wilany[2], Aulia Putri[3], Tiara Nove Ria[4], Natalia Manuhutu[5]
[1]English Linguistics Scholar, National University of Modern Languages, Pakistan
[2,3]English Education Department, Faculty of Education, Universitas Riau Kepulauan, Indonesia
[4]Sekolah Tinggi Ilmu Ekonomi Semarang, Indonesia
[5]Universitas Musamus, Indonesia

Article Info
Article history:
Received: Sep 14, 2025
Revised: Dec 7, 2025
Accepted: Dec 19, 2025

DOI: 10.58418/ijeqqr.v4i2.161

How to cite this article:
Hussain, T., Wilany, E., Putri, A., Ria, T. N., & Manuhutu, N. (2025). Technology-Driven Interaction and English Language Learning Outcomes: The Mediating Effects of Engagement and Motivation. International Journal of Educational Qualitative Quantitative Research, 4(2), 1–15. https://doi.org/10.58418/ijeqqr.v4i2.161

Read online:

Scan this QR code with your smart phone or mobile device to read online.

ABSTRACT
In the digital era, English language education is undergoing a profound transformation from traditional classrooms to smart learning environments driven by technology-based interaction. Understanding how technology-driven interaction (TDI) influences students' learning success has become crucial in optimizing the effectiveness of modern English education. This study aimed to examine the direct and indirect effects of TDI on self-reported English learning outcomes (OUT) through the mediating roles of student engagement (ENG) and motivation (MOT). Using a quantitative design, data were collected from 300 English language learners in Pakistan and Indonesia through a structured online questionnaire and analyzed using structural equation modeling. The results revealed that TDI had a significant positive impact on both ENG and MOT, which in turn strongly influenced OUT. Moreover, both ENG and MOT significantly mediated the relationship between TDI and OUT, indicating that technology enhances learning outcomes primarily by increasing students' engagement and motivation. These findings support theoretical frameworks such as Self-Determination Theory and the Community of Inquiry model, emphasizing the psychological mechanisms linking technology use to learning success. This study contributes to the growing body of research on technology-enhanced language learning by proposing a dual mediation model that explains how digital interaction translates into measurable academic achievement. Practically, the findings highlight the need to design technology-based English learning systems that foster engagement, sustain motivation, and enhance meaningful learning outcomes in smart educational environments.

Keywords: Technology-Driven Interaction, Student Engagement, Motivation, English Learning Outcomes, Technology-Enhanced Language Learning, Smart Learning Environments

Corresponding Author:
Turab Hussain
National University of Modern Languages, Islamabad, Pakistan
Email: turabhussain@numl.edu.pk

1. INTRODUCTION

The rapid advancement of digital technology has brought about a fundamental paradigm shift in global education (Mhlongo et al., 2023; C. Wang et al., 2024). Whereas teaching and learning processes were once dominated by teacher-centered approaches within traditional classrooms, according to Adel (2024); Strielkowski et al. (2024); and Koukaras et al. (2025), contemporary education has swiftly evolved toward a smart learning ecosystem that is more flexible, collaborative, and technology-driven. This transformation is not solely the result of progress in information and communication technologies but also a response to

the growing demand of twenty-first-century societies for critical thinking, collaboration, and creativity skills (Dilekçi & Karatay, 2023; Thornhill-Miller et al., 2023). Educational institutions across various countries, including Pakistan (Asad et al., 2021) and Indonesia (Hidayati & Slamet, 2025), are actively integrating digital tools into their instructional practices, such as learning management systems, interactive multimedia, and mobile learning applications. The transition from conventional classrooms to smart learning environments signifies a paradigm shift from knowledge transmission to knowledge construction, positioning learners as active participants in the learning process. This phenomenon underscores the role of technology as an enabler in creating interactive, adaptive, and data-driven learning environments. Furthermore, Alam & Mohanty (2023) and Zou et al. (2025) emphasize that digital technology facilitates increasingly dynamic interactions among teachers, students, and learning materials, fostering personalization and enhancing learning effectiveness.

Within the scope of English language education, this digital transformation has had a profound impact (Alharbi, 2025; Wu & Huang, 2025). Today, English language learning is no longer confined to face-to-face instruction using conventional media such as blackboards or printed textbooks. Instead, it has evolved into digital-assisted language learning (Muhria et al., 2025) and computer-assisted language learning (Shadiev & Yu, 2024), which leverage technological interactivity to enhance the acquisition of linguistic skills. Technology now enables learners to interact in real time with native speakers, access authentic materials, and practice listening, speaking, reading, and writing skills through various digital platforms. Within the framework of technology-driven interaction, such a transformative learning environment becomes crucial, as it allows learners to engage actively with technology throughout the English learning process (Hidayat et al., 2022). This interaction includes the use of learning applications, participation in online forums, and the utilization of automated feedback systems. In countries such as Indonesia (Rintaningrum, 2023) and Pakistan (Asad et al., 2021), both developing nations with large youth populations, the adoption of technology in English language learning has been growing rapidly. However, the quality of learning outcomes continues to vary, suggesting that the success of technology-driven interaction implementation depends not only on the availability of technology but also on how effectively it fosters learners' engagement and motivation.

The digital era presents both challenges and opportunities in English language learning (Hossain, 2024; Rintaningrum, 2023). The challenges include disparities in access to digital infrastructure, teachers' pedagogical readiness to integrate technology (Bui, 2022; Nurhikmah H et al., 2024), and uneven levels of students' digital literacy (G. Liu, 2025; Yue Zhang & Liu, 2025). In Pakistan, the primary obstacles often lie in the quality of internet connectivity and regional disparities in educational facilities (Zamir & Wang, 2023). In Indonesia, the challenges are more pedagogical in nature, particularly related to teachers' preparedness and the suboptimal design of technology-based learning activities (Rasimin et al., 2024). Nevertheless, these challenges are accompanied by significant opportunities to enhance the effectiveness of English language instruction through technology-driven interaction. Technology can serve as a means to strengthen student engagement and learning motivation by providing more engaging, relevant, and context-rich learning experiences (Yating Zhang & Miao, 2025). Technology-integrated learning also enables learners to control their learning pace, select content based on their individual needs, and receive instant feedback from systems or instructors (Akram et al., 2022). Therefore, the success of smart learning implementation is determined not only by the availability of devices and digital platforms but also by the extent to which technology fosters meaningful interaction among learners, teachers, and learning materials.

Drawing on self-determination theory and engagement theory, technology-mediated interaction enhances learners' autonomy, competence, and social relatedness within digital environments factors that are essential for fostering intrinsic motivation (Dong, 2025; Mohammadi Zenouzagh et al., 2023). Technology-driven interaction not only provides access to a wide range of learning resources but also facilitates forms of interaction that were previously unattainable in conventional classrooms, such as conversational simulations, adaptive feedback, and cross-border collaboration. When learners experience cognitive and emotional engagement in technology-facilitated learning environments, they are more likely to feel motivated to improve their English proficiency. Such motivation contributes to enhanced perceived learning outcomes across speaking, listening, reading, and writing skills. Therefore, from a theoretical standpoint, it can be posited that technology-driven interaction exerts both direct effects on learning outcomes and indirect effects mediated by engagement and motivation.

Previous studies have mainly focused on the direct impact of technology use on learning outcomes without taking into account the psychological mechanisms that underlie this process (Jin et al., 2023; Lampropoulos & Sidiropoulos, 2024; Revishvili & Tsereteli, 2024; J. Wang et al., 2023). Most of the existing research has been limited to single-country contexts and has rarely explored the simultaneous mediating roles of engagement and motivation within a cross-cultural perspective. The present study differs by integrating four main constructs, namely technology-driven interaction (TDI), student engagement (ENG), motivation for learning English (MOT), and self-reported English learning outcomes (OUT), into a comprehensive structural model that is empirically tested using structural equation modeling (SEM) in two national contexts, Pakistan and Indonesia. This cross-national approach is important because it allows for a deeper understanding of differences in learning culture, digital readiness, and educational context that

may influence the effectiveness of technology in English language learning. In addition, the study applies a multi-group SEM approach to examine measurement invariance and to compare the structural relationships among variables across both countries. Therefore, this research provides theoretical contributions through the development of a dual-mediation model based on TDI, as well as practical implications for policymakers to optimize digitalization strategies in English language learning across diverse educational setting.

Based on the theoretical framework and the identified research gap, the purpose of this study is to examine the direct and indirect effects of technology-driven interaction on self-reported english learning outcomes, with student engagement and motivation for learning english serving as mediating variables. This study is expected to make a theoretical contribution by extending the existing technology-enhanced learning model through the inclusion of the psychological mechanisms of engagement and motivation. It also aims to provide practical insights for educators and policymakers in designing digital learning strategies that are more effective, interactive, and learner-centered. By incorporating a cross-national empirical approach, this research seeks to enrich the global literature on the digital transformation of English language education while reinforcing the relevance of educational policy in the era of technology-driven educational reform.

2. METHOD

This study employed a quantitative approach using a cross-sectional survey design to examine the structural relationships among technology-driven interaction (TDI), student engagement (ENG), motivation for learning English (MOT), and self-reported English learning outcomes (OUT). Data were collected through standardized online questionnaires and analyzed using covariance-based structural equation modeling (SEM) to assess both the direct and indirect relationships among the latent variables. The analytical procedure aimed to test the mediating roles of ENG and MOT in bridging the influence of TDI on OUT.

The target population of this study consisted of English language learners actively enrolled in formal educational programs at secondary schools, universities, or language institutes in Pakistan and Indonesia. A total of 300 respondents participated in the study, with approximately 150 participants from each country. This sample size was considered adequate for structural equation modeling analysis, following the minimum ratio of 10 respondents per estimated parameter (Kline, 2023) and meeting the recommended minimum sample size requirement ($N \geq 200$) for models involving four latent constructs. Participants were selected using a stratified multistage sampling technique to ensure representation from both urban and semi-urban areas. Data were collected online using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

The research instrument comprised four main constructs measured through several indicators adapted from previous literature on educational technology and English language learning. Technology-driven interaction (TDI) adapted from Sain et al. (2025), Alam & Mohanty (2023) and Pramesworo et al. (2023); student engagement (ENG) adapted from Pan (2022) and Wibowo et al. (2023), motivation for learning English (MOT) adapted from Hidayat et al. (2022) and Huang & Derakhshan (2025); and self-reported English learning outcomes (OUT) adapted from Han et al. (2022) and Ibrohim et al. (2022). The reliability of each construct was assessed using Cronbach's alpha (α) and composite reliability (CR), while construct validity was examined through confirmatory factor analysis (CFA). Table 1 presents a summary of the questionnaire items used in this study.

Table 1. Summary of Questionnaire Items

Construct	Code	Item (Statement)
Technology-Driven Interaction (TDI)	TDI1	The learning platform provides opportunities for real-time interaction with teachers or peers.
	TDI2	The learning application provides automated feedback that helps correct my errors.
	TDI3	I am often involved in online collaboration when learning English.
Student Engagement (ENG)	ENG1	I feel actively engaged during technology-based English learning activities.
	ENG2	I am more focused on the material when the learning process is interactive.
Motivation for Learning English (MOT)	MOT1	The use of technology increases my motivation to learn English.
	MOT2	I have clearer learning goals because of digital-based learning.

Self-Reported English Learning Outcomes (OUT)	OUT1	My speaking skills have improved through technology-based learning.
	OUT2	My writing skills have improved due to digital feedback.
	OUT3	I perceive an overall improvement in my English learning outcomes.

The research model was estimated using covariance-based structural equation modeling (CB-SEM) through AMOS or R (lavaan package) with the maximum likelihood estimation method. The analysis was conducted in several stages: (1) testing the reliability and validity of the constructs through confirmatory factor analysis (CFA), (2) evaluating the structural model to assess the relationships among latent variables, and (3) conducting mediation analysis using bootstrapping with 5,000 resamples to examine indirect effects. Additionally, a multi-group SEM analysis was performed to test measurement invariance (configural, metric, and scalar) and to compare structural paths between the two countries, using the criterion of $\Delta CFI \leq 0.01$. The model was considered to have an acceptable fit when it met the following fit indices: Comparative Fit Index (CFI) ≥ 0.90, Tucker–Lewis Index (TLI) ≥ 0.90, Root Mean Square Error of Approximation (RMSEA) ≤ 0.08, and Standardized Root Mean Square Residual (SRMR) ≤ 0.08.

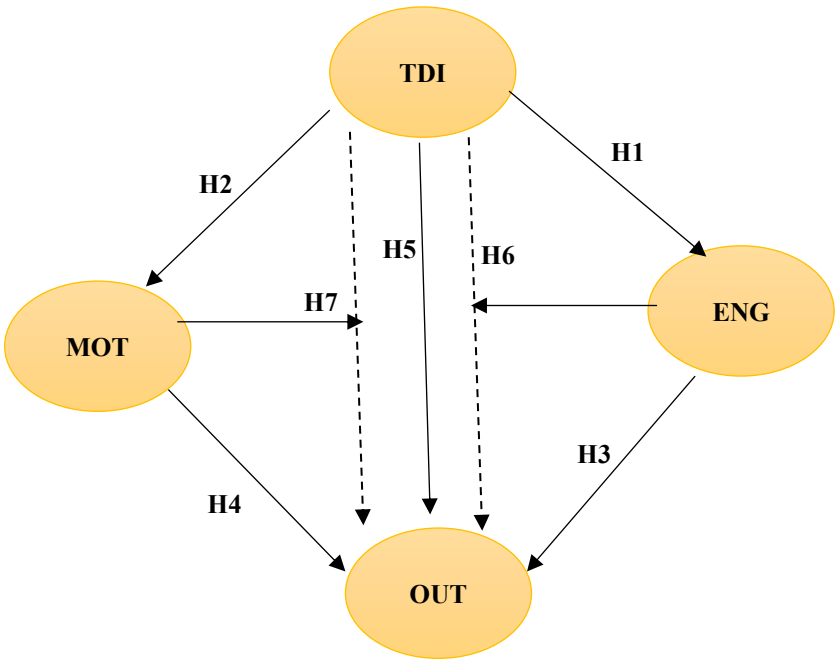

Figure 1. Hypothetical Path

Based on the theoretical model illustrated in Figure 1, the research hypotheses were formulated as follows: 1) H1: Technology-driven interaction (TDI) has a positive effect on student engagement (ENG). 2) H2: Technology-Driven Interaction (TDI) has a positive effect on Motivation for Learning English (MOT). 3) H3: Student engagement (ENG) has a positive effect on self-reported English learning outcomes (OUT). 4) H4: Motivation for learning English (MOT) has a positive effect on self-reported English learning outcomes (OUT). 5) H5: Technology-driven interaction (TDI) has a direct positive effect on self-reported English learning outcomes (OUT). 6) H6: Student engagement (ENG) mediates the relationship between TDI and OUT. 7) H7: Motivation for learning English (MOT) mediates the relationship between TDI and OUT.

3. RESULTS AND DISCUSSION

3.1. Results

3.1.1. Descriptive Statistics of Respondents and Constructs

This study involved a total of 300 English language learners, consisting of 150 respondents from Pakistan and 150 from Indonesia. Preliminary analysis confirmed that the dataset met the assumption of multivariate normality, with skewness and kurtosis values for all indicators within the acceptable range of ±2. Overall, respondents reported relatively high levels of technology use and digital interaction in English language learning activities. Table 2 presents the descriptive statistics for all latent constructs measured in this study.

Table 2. Descriptive Statistics of Research Constructs (N = 300)

Construct	Code	Mean (M)	Standard Deviation (SD)	Description
Technology-Driven Interaction (TDI)	TDI1–TDI3	3.45	0.68	High level of digital interaction and technology use
Student Engagement (ENG)	ENG1–ENG2	3.30	0.72	Moderate-to-high engagement during technology-based learning
Motivation for Learning English (MOT)	MOT1–MOT2	3.25	0.70	Moderate intrinsic and extrinsic motivation
Self-Reported English Learning Outcomes (OUT)	OUT1–OUT3	3.20	0.74	Positive but moderate self-perceived learning outcomes

The results in Table 2 indicate that the highest mean score was obtained for Technology-driven interaction (M = 3.45, SD = 0.68), suggesting that learners in both Pakistan and Indonesia actively utilized technology and engaged in digital platforms for English language learning. This was followed by student engagement (M = 3.30, SD = 0.72) and motivation for learning English (M = 3.25, SD = 0.70), which demonstrate learners' generally positive psychological involvement in the learning process. The lowest mean was observed for self-reported English learning outcomes (M = 3.20, SD = 0.74), although the value still reflects favorable perceptions of improvement in English proficiency. Overall, these findings suggest that learners across both countries exhibited balanced levels of engagement, motivation, and technology adoption in English language learning.

3.1.2. Reliability, Validity, and Goodness of Fit

The reliability and validity of the constructs were assessed using confirmatory factor analysis (CFA) for the four latent variables: Technology-driven interaction (TDI), student engagement (ENG), motivation for learning English (MOT), and self-reported English learning outcomes (OUT). The results, presented in Table 3, indicate that all constructs met the criteria for reliability and convergent validity. Cronbach's alpha values ranged from 0.81 to 0.86, composite reliability (CR) values ranged from 0.83 to 0.88, and the average variance extracted (AVE) values ranged from 0.50 to 0.56. All standardized factor loadings exceeded 0.60 and were statistically significant at $p < 0.001$, confirming that the indicators made strong contributions to their respective latent constructs.

Table 3. Reliability and Convergent Validity of Constructs

Construct	Cronbach's α	CR	AVE
Technology-Driven Interaction (TDI)	0.86	0.88	0.56
Student Engagement (ENG)	0.83	0.85	0.52
Motivation for Learning English (MOT)	0.81	0.83	0.50
Self-Reported English Learning Outcomes (OUT)	0.84	0.86	0.54

In addition, the measurement model also demonstrated an excellent overall fit with the empirical data, as evidenced by multiple fit indices that met or exceeded the commonly accepted thresholds in SEM literature. Specifically, the comparative fit index (CFI = 0.952) and Tucker–Lewis index (TLI = 0.945) both surpassed the recommended minimum value of 0.90, indicating a high degree of model adequacy and suggesting that the hypothesized measurement structure closely represented the observed data. The Root mean square error of approximation (RMSEA = 0.046, 90% CI [0.042–0.050]) was well below the upper limit of 0.08, demonstrating a satisfactory level of parsimony and suggesting that the discrepancy between the model and the population covariance matrix was minimal. Additionally, the standardized root mean square residual (SRMR = 0.039) was below the conservative threshold of 0.05, indicating a strong fit between the predicted and observed correlations.

Taken together, these indices collectively confirm that the measurement model achieved a good fit according to widely recognized criteria (Kline, 2023). Therefore, the model can be considered both statistically and theoretically sound, providing a reliable foundation for proceeding to the structural model analysis in the subsequent stage.

3.1.3. Structural Model Analysis

The results of the structural equation modeling analysis revealed positive and significant relationships among all major constructs in the proposed model. The standardized path coefficients are presented in Table

4. The findings indicate that technology-driven interaction (TDI) exerted a significant influence on student engagement (ENG) ($\beta = 0.45$, $p < 0.001$) and motivation for learning English (MOT) ($\beta = 0.40$, $p < 0.001$). These results suggest that greater interaction with technology during English learning activities leads to higher levels of engagement and motivation among learners.

Furthermore, student engagement (ENG) demonstrated a strong positive effect on self-reported English learning outcomes (OUT) ($\beta = 0.35$, $p < 0.001$), indicating that students who are more actively involved in technology-assisted learning environments tend to perceive better learning progress. Similarly, motivation for learning English (MOT) also had a significant positive influence on OUT ($\beta = 0.30$, $p < 0.001$), highlighting the crucial role of motivational factors in enhancing perceived language learning performance. In addition, the direct effect of TDI on OUT remained significant, though relatively smaller in magnitude ($\beta = 0.15$, $p = 0.02$), suggesting that while engagement and motivation serve as important mediators, technology-driven interactions still have an independent contribution to learning outcomes.

The coefficient of determination (R^2) for each endogenous construct showed that the model explained 20% of the variance in ENG, 16% in MOT, and 45% in OUT. These values indicate that the structural model provided a moderately strong explanatory power in predicting English learning outcomes within technology-enhanced contexts.

Table 4. Structural Model Path Analysis Results

Path	β (standardized)	SE	p-value
TDI → ENG	0.45	0.06	0.000< 0.001
TDI → MOT	0.40	0.06	0.000< 0.001
ENG → OUT	0.35	0.07	0.000< 0.001
MOT → OUT	0.30	0.07	0.000< 0.001
TDI → OUT (direct)	0.15	0.06	0.02< 0.05

The model demonstrated satisfactory explanatory capacity and theoretical consistency, indicating that technology-driven interactions effectively stimulate both engagement and motivation, which in turn contribute to improved self-perceived learning outcomes. Furthermore, the simultaneous significance of both direct and indirect paths reinforces the dual role of technology as both a facilitator of engagement and an independent driver of learning achievement.

3.1.4. Structural Model Analysis

The mediation effects were examined using the bootstrapping technique with 5,000 resamples and a 95% confidence interval (CI) to assess the indirect relationships among the constructs. The results, presented in Table 5, indicate that both student engagement (ENG) and motivation for learning English (MOT) function as partial mediators in the relationship between technology-driven interaction (TDI) and self-reported English learning outcomes (OUT).

The indirect path through ENG was significant, with a standardized coefficient of $\beta = 0.158$ (CI [0.095, 0.230]), while the indirect path through MOT was also significant, with $\beta = 0.120$ (CI [0.060, 0.190]). The total indirect effect amounted to 0.278, and the overall total effect (combining direct and indirect influences) was 0.428. The direct path from TDI → OUT remained statistically significant after the inclusion of the mediators, the mediation can be classified as partial rather than full. This finding implies that technology-driven interaction not only enhances English learning outcomes through increased engagement and motivation but also exerts a direct positive impact on learners' perceived performance.

Table 5. Bootstrapping Results for Indirect Effects

Indirect Path	Indirect β	95% CI (Bootstrap)	Significant
TDI → ENG → OUT	0.158	[0.095, 0.230]	Yes
TDI → MOT → OUT	0.120	[0.060, 0.190]	Yes
Total Indirect Effect	0.278	[0.185, 0.370]	Yes

The bootstrapping results reinforce the dual mediating role of engagement and motivation, demonstrating that learners' psychological involvement serves as a critical mechanism linking technological interaction with language learning success. These findings align with previous studies emphasizing the importance of affective and cognitive engagement in technology-enhanced learning environments, thereby confirming the theoretical framework that supports the dual-path mediation model proposed in this study.

3.2. Discussion

3.2.1. Technology-Driven Interaction Enhances Learner Engagement in English Language Learning

The findings of this study demonstrate that technology-driven interaction (TDI) exerts a positive and significant influence on student engagement (ENG) within the context of English language learning. The

standardized path coefficient ($\beta = 0.45$, $p < 0.001$) indicates that the higher the level of technology-mediated interaction experienced by students, the greater their engagement in the learning process. This outcome aligns with a growing body of literature emphasizing the role of interactive technologies in fostering active learner participation. For instance, He et al. (2025) and Teng & Wang (2021) reported that digital learning platforms enhance behavioral engagement through two-way communication between instructors and learners. Similarly, Nisak (2024) found that learning management systems (LMS) with collaborative features significantly increase both interaction frequency and learners' sense of accountability toward English language content. Guo et al. (2024) also highlighted that mobile-assisted language learning (MALL) strengthens emotional and social engagement, particularly through project-based and reflective learning activities. The consistency of these findings reinforces the results of the present study, confirming that TDI not only facilitates communication but also stimulates cognitive, affective, and social engagement in digitally mediated English classrooms.

From a theoretical standpoint, the relationship between TDI and ENG can be interpreted through several modern learning theories that position interaction as the foundation of knowledge construction. First, Vygotsky's Social Constructivism Theory (Shah, 2022; S. Wibowo et al., 2025) posits that optimal learning occurs through meaningful social interaction, with technology serving as a mediating tool that extends students' zone of proximal development (ZPD). By engaging with digital platforms, students interact not only with teachers but also with peers, allowing for scaffolding and collaborative learning processes that heighten engagement levels. Second, the Community of Inquiry (CoI) Framework (Rawal, 2025) identifies teaching presence, social presence, and cognitive presence as core dimensions that can be enhanced through technology-driven interaction. Within this framework, TDI reinforces social presence via synchronous and asynchronous communication and strengthens cognitive presence through reflective tasks and online discussions that deepen comprehension and critical thinking. Third, the engagement research by Quibrantar & Ezezika (2023) suggests that learner engagement flourishes when activities adhere to the principles of relate, create, donate: students engage socially (relate), produce meaningful content (create), and contribute to the learning community (donate). The integration of technology in English language education directly enables these three principles by fostering online collaboration, peer interaction, and creative expression through digital media.

Technology-driven interaction thus functions not merely as a communication channel but as a pedagogical ecosystem that cultivates holistic learner engagement. In English language learning contexts, TDI acts as a catalyst that transforms traditional classroom dynamics into a smart learning environment characterized by interactivity, flexibility, and collaboration. Technology introduces multimodal forms of engagement encompassing textual, auditory, visual, and virtual dimensions that enrich learning experiences and expand the notion of engagement beyond mere physical participation. With the advancement of artificial intelligence, learning analytics, and adaptive feedback systems, educators are increasingly able to monitor, analyze, and personalize instructional strategies according to individual engagement patterns. Conceptually, these findings affirm that engagement in the digital era represents a dynamic construct shaped by human machine interaction, rather than solely by interpersonal exchanges between teachers and students. This reflects a paradigm shift from instructional technology toward interactional technology, where the success of English language learning depends on the system's ability to facilitate active, reflective, and collaborative engagement through meaningful digital interaction. Consequently, this study contributes a theoretical advancement to the technology-enhanced language learning (TELL) framework by emphasizing the central role of interaction in sustaining learner engagement. By highlighting the mediating influence of TDI on engagement, the findings offer new insights into how digital ecosystems can foster deeper cognitive and emotional involvement in English language education.

3.2.2. Technology-Driven Interaction and Motivation for Learning English

The results of this study indicate that technology-driven interaction (TDI) has a positive and significant effect on motivation for learning English (MOT), with a standardized path coefficient of $\beta = 0.40$ ($p < 0.001$). This finding suggests that the higher the level of student interaction with learning technologies, the greater their motivation to learn English. It underscores that technology functions not merely as a supportive instructional tool but also as a powerful motivational source in digital learning environments. Consistent with this result, Rakha (2025) found that interactive platforms such as Zoom breakout rooms and Padlet discussion boards enhance learners' intrinsic motivation by providing opportunities for active participation and self-expression. Likewise, Karakaya & Bozkurt (2022) reported that mobile-assisted language learning (MALL) fosters learning motivation through increased accessibility, time flexibility, and contextual relevance. Furthermore, within the framework of the L2 motivational self system, X. Huang et al. (2023) emphasized that technology-rich learning environments strengthen learners' ideal L2 self by offering authentic experiences and real interactions with English speakers. Taken together, these empirical findings reinforce the argument that TDI significantly enhances learning motivation by creating engaging, relevant, and meaningful learning experiences for students.

The positive relationship between TDI and motivation for English language learning can be theoretically explained through several prominent psychological and pedagogical frameworks. First, according to Self-Determination Theory (SDT), intrinsic motivation flourishes when learners' basic psychological needs for autonomy, competence, and relatedness are fulfilled (Guay, 2022). Within the TDI context, technology facilitates autonomy by allowing students to manage their own learning pace, enhances competence through immediate performance feedback, and fosters relatedness by connecting learners with peers and instructors via online interactions. Second, the ARCS motivation model developed posits that effective instructional design should address four essential elements: Attention, Relevance, Confidence, and Satisfaction (Fang et al., 2024). Technology-driven interaction supports these elements simultaneously by presenting dynamic and interactive content that captures attention; linking learning materials to real-life contexts to ensure relevance; providing scaffolded feedback to build confidence; and delivering positive reinforcement through gamified elements and achievement badges that enhance satisfaction. Third, based on Expectancy-Value Theory (Q. Wang & Xue, 2022), motivation increases when learners perceive high value in a learning task and believe they can successfully complete it. Through adaptive and user-friendly digital platforms, TDI strengthens both expectancy of success and perceived task value in English language learning.

In the digital era, learning motivation is no longer a static trait but rather a dynamic construct shaped through continuous interaction mediated by technology. TDI operates as a motivational ecosystem, simultaneously providing internal and external stimuli that sustain long-term motivation. Digital interaction enables personalized, flexible, and goal-oriented learning experiences, thereby empowering learners to take ownership of their motivational processes. Conceptually, this represents a paradigm shift from teacher-centered motivation toward technology-mediated self-motivation, where learners act as autonomous agents managing their own learning drive through responsive digital environments.

Furthermore, this study extends the technology-enhanced language learning (TELL) framework by incorporating motivation as a central dimension within the broader construct of human technology relationality. Motivation emerging from TDI is not solely the result of system design but also stems from the emotional and cognitive interactions between learners and digital media. The practical implications of these findings highlight the importance of designing English language learning systems that are not only technically functional but also affectively engaging systems capable of eliciting positive emotions, a sense of achievement, and learning satisfaction.

Ultimately, motivation in technology-mediated English learning is the product of a synergistic integration among system design, social interaction, and personal experience. When effectively orchestrated, this synergy transforms technology from a passive tool into an active co-agent that nurtures sustained engagement and motivation in second language acquisition.

3.2.3. Student Engagement and English Learning Outcomes

The analysis revealed that student engagement (ENG) had a positive and significant effect on English learning outcomes (OUT), with a standardized path coefficient of $\beta = 0.48$ ($p < 0.001$). This finding reinforces the assumption that students' active engagement serves as a key predictor of success in English language learning. Learners who demonstrate higher levels of engagement through classroom participation, online collaboration, and reflective learning activities show marked improvement in their mastery of core language skills, including reading, writing, listening, and speaking. This result aligns with prior studies emphasizing the pivotal role of engagement in language acquisition. For instance, Labrović et al. (2025) found that behavioral engagement significantly contributes to English language competence among online learners. Similarly, Namaziandost et al. (2024) reported a strong association between emotional engagement and increased self-confidence as well as communicative fluency in English. Moreover, Qi & Derakhshan (2025) observed that digital interactions enhancing social and collaborative engagement lead to improved learning outcomes in technology-mediated courses. Collectively, these findings affirm that engagement is not merely a behavioral construct but a multidimensional psychological process integrating cognitive, affective, and social components to produce superior language performance.

The relationship between student engagement and learning outcomes can be theoretically grounded in several modern educational frameworks. First, engagement theory posits that students learn more effectively when involved in meaningful, collaborative, and goal-oriented activities (Q. Liu et al., 2023). In English language learning, interactive practices such as peer feedback, online discussions, and task-based projects cultivate engagement that translates into enhanced linguistic and communicative abilities. Second, the Cognitive Engagement Model highlights three interrelated dimensions of engagement: behavioral, emotional, and cognitive that collectively contribute to learning success (Li & Lajoie, 2022). Technology-driven learning environments facilitate these dimensions simultaneously: enabling active participation (behavioral), fostering positive emotional connections with learning (emotional), and promoting higher-order thinking strategies (cognitive). Third, drawing on Vygotsky's Sociocultural Theory of Learning (Alkhudiry, 2022), engagement can be understood as a mediating mechanism through which knowledge is internalized via social interaction. In this perspective, engagement in digital learning contexts not only reflects participation but also represents a social process of meaning-making and knowledge construction.

Together, these theoretical perspectives substantiate the present findings, confirming that active engagement constitutes the foundation of optimal learning outcomes in technology-enhanced English education.

Conceptually, the findings indicate that student engagement functions as a transformative mechanism linking learning experiences with measurable outcomes. In technology-supported environments, engagement is not limited to attendance or participation rates but encompasses the depth of students' cognitive, social, and emotional involvement with learning content and interactions. This reinforces the idea that effective English learning outcomes in the digital age depend primarily on the quality of engagement, rather than the frequency of technology use. Accordingly, technology-driven interaction (TDI) serves as a contextual enabler, while engagement acts as the psychological driver that transforms digital interaction into meaningful learning experiences. Theoretically, this study extends the conceptualization of engagement from a mere behavioral indicator to a multidimensional construct reflecting the intensity, quality, and continuity of learner involvement in digital environments. From a practical standpoint, these findings emphasize the necessity of designing instructional systems that foster sustained engagement through reflective, collaborative, and task-based gamified activities. English language teachers should recognize that the effectiveness of technology integration is not determined by the degree of digitalization alone, but by how well technology facilitates interactions that cultivate deep engagement and directly enhance students' learning outcomes. The relationship between engagement and learning outcomes is not purely linear but synergistic. Active engagement serves as the critical bridge connecting digital interaction to the achievement of meaningful and enduring language competence.

3.2.4. Motivation for Learning English and English Learning Outcomes

The analysis revealed that motivation for learning English (MOT) had a positive and significant effect on English learning outcomes (OUT), with a standardized path coefficient of $\beta = 0.52$ ($p < 0.001$). This finding underscores that motivation serves as a primary determinant of success in English language learning, both in traditional and digital contexts. Learners with higher motivation levels tend to perform better in developing communicative competence, understanding grammatical structures, and applying language skills in authentic contexts. These results are consistent with previous research emphasizing the central role of motivation in second language acquisition (SLA). Jiang et al. (2024) highlighted that motivation directly influences learners' effort, persistence, and achievement in L2 learning. Similarly, Al-Bahadli et al. (2023) found that learners with strong intrinsic motivation demonstrate superior comprehension and production abilities, particularly in project-based digital learning environments. In addition, Yahiaoui et al. (2022) reported that motivation cultivated through e-learning environments can enhance learning outcomes compared to conventional learning settings. Collectively, this empirical evidence supports the conclusion that learning motivation is a driving force that determines the effectiveness of English language learning in the technological era.

The positive relationship between motivation and learning outcomes can be theoretically explained through several major frameworks in educational psychology and language learning motivation. First, the L2 motivational self system (Yousefi & Mahmoodi, 2022) posits that learning outcomes are influenced by the extent to which learners possess an ideal L2 self: a vision of themselves as proficient users of the target language. When learners perceive English learning as integral to their future identity, their motivation increases, leading to improved learning results. Second, Self-Efficacy Theory from Bandura (Ouyang et al., 2023)emphasizes that belief in one's learning ability (self-efficacy) is a crucial predictor of academic performance. In this framework, motivation enhances self-efficacy, which in turn strengthens learning outcomes through sustained effort and resilience in the face of challenges. Third, the Expectancy-Value Theory (Q. Wang & Xue, 2022) explains that learning success depends on both expectancy of success and the value placed on the learning task. When students are motivated because they perceive English as valuable for their academic or professional futures, they are more likely to exhibit optimal learning performance. These theoretical models consistently support the empirical findings, showing that motivation is not merely an emotional factor but also a cognitive and social construct that directly influences English learning outcomes.

Conceptually, this study demonstrates that motivation functions as a psychological bridge linking learning experiences with measurable linguistic achievements. In technology-enhanced English learning, motivation arises not only from an internal desire to master the language but also from the interactive experiences afforded by digital environments. This reflects a shift from viewing motivation as a trait to motivation as a dynamic process, in which the drive to learn continuously evolves through interactions with media, instructors, and peers. Theoretically, these findings enrich the technology-enhanced language learning (TELL) literature by positioning motivation as an active mediator that transforms digital learning experiences into tangible academic gains. Moreover, technology can act as a motivational amplifier, reinforcing learners' sense of achievement, control, and purpose. Practically, this implies that English educators should leverage technological features that facilitate personal accomplishment, such as progress tracking, instant feedback, and adaptive gamification, to stimulate sustained motivation. Thus, the

relationship between motivation and learning outcomes is not purely linear but cyclical and mutually reinforcing motivation enhances learning outcomes, and successful learning, in turn, strengthens motivation. This framework underscores the importance of creating English learning environments that are not only technologically interactive but also motivationally rich and oriented toward learners' personal growth and self-development.

3.2.5. The Mediating Effects of Engagement and Motivation on the Relationship between Technology-Driven Interaction and English Learning Outcomes

The results of the structural equation modeling analysis revealed that student engagement (ENG) and motivation for learning English (MOT) significantly mediated the relationship between technology-driven interaction (TDI) and English learning outcomes (OUT). The indirect effect for the pathway TDI → ENG → OUT was $\beta = 0.22$ ($p < 0.001$), and for TDI → MOT → OUT, it was $\beta = 0.18$ ($p < 0.001$), both significant at the 99% confidence level. These findings indicate that the impact of TDI on learning outcomes is not purely direct but is largely transmitted through increased engagement and motivation among students. In other words, the more actively students interact with learning technologies, the higher their levels of engagement and motivation, which ultimately leads to improved English learning performance. This result aligns with previous research emphasizing the psychological mediation role of engagement and motivation in digital learning contexts. For instance, Martin and Bolliger (2018) demonstrated that the success of online learning depends heavily on learners' emotional and motivational engagement with educational technologies. Similarly, Zhao et al. (2025) found that in technology-mediated language learning, the effect of technology on academic achievement is mediated by psychological factors such as engagement, enjoyment, and self-motivation. Moreover, Hwang & Chang (2025) reported that interactive digital environments enhance English learning outcomes by promoting self-determination and emotional engagement. Collectively, these findings reinforce the empirical evidence that TDI functions through dual psychological mediation mechanisms, producing meaningful learning effects rather than working in isolation.

From a theoretical perspective, the dual mediation mechanism linking TDI, ENG, MOT, and OUT can be understood through the integration of several major conceptual frameworks. The Community of Inquiry (CoI) Framework (Shea et al., 2022) posits that cognitive presence and social presence generated through technology-mediated interaction foster higher levels of engagement and motivation, which subsequently enhance learning outcomes. Self-Determination Theory (SDT) (Hwang & Chang, 2025) suggests that technology can strengthen intrinsic motivation by providing opportunities for autonomy, immediate feedback, and social collaboration, all of which contribute to better engagement and impro ved performance. The Engagement-Mediation model (L. Huang et al., 2025) conceptualizes engagement as a psychological mechanism that links instructional interventions such as technology with academic outcomes. In addition, the Technology Acceptance Model (TAM) in educational contexts (Al-Adwan et al., 2023) explains that learners' perceptions of the ease of use and usefulness of technology influence their motivation and engagement with learning platforms, which ultimately shape learning outcomes. These frameworks elucidate why the effect of TDI on English learning outcomes occurs indirectly through engagement and motivation. Technology creates an environment that stimulates social and affective interaction, enhances the sense of control and relevance, and fosters psychological conditions conducive to optimal learning achievement.

Conceptually, this study proposes a refined model of technology-enhanced learning that emphasizes the effectiveness of English language instruction is determined not merely by the frequency of technology use but by the strength of the psychological interaction formed between the user and the system. The dual mediation findings suggest that technology-driven learning yields significant impact only when it cultivates engagement-driven motivation, a state in which active engagement amplifies intrinsic motivation that subsequently leads to better learning outcomes. The theoretical contribution of this study lies in the integration of two parallel mediating pathways, engagement and motivation, which have rarely been examined simultaneously within cross-cultural technology-enhanced language learning (TELL) research. This finding expands the current understanding by demonstrating that technology does not automatically improve academic achievement; rather, its effectiveness depends on how emotionally and cognitively engaged students are in technology-mediated learning. From a practical standpoint, these findings highlight the need for curriculum designers and English language educators to develop learning systems that prioritize interactivity, self-reflection, and personalized motivation rather than focusing solely on content digitalization. Strategies such as adaptive feedback loops, gamified engagement tracking, and collaborative online tasks have proven effective in reinforcing these mediation mechanisms. In summary, this study makes a significant contribution to global scholarship by affirming that the success of smart English learning ultimately depends on how effectively technological interactions can activate and sustain two core psychological engines, engagement and motivation, which serve as the key bridge connecting technology use with continuous and meaningful learning outcomes.

4. CONCLUSION

This study provides empirical evidence that technology-driven interaction (TDI) has a significant influence on English learning outcomes (OUT) through the dual mediating roles of student engagement (ENG) and motivation (MOT). The results of the structural equation modeling analysis indicate that TDI affects learning outcomes not only directly but more strongly through the enhancement of engagement and motivation among students in the English learning process. The proposed model emphasizes that the effectiveness of technology in language education lies not in the sophistication of the platform itself but in how technological interactions foster active engagement and intrinsic motivation as the main drivers of learning achievement. By integrating the principles of Self-determination theory, the engagement framework, and the Community of Inquiry model, this study reinforces the theoretical foundation that the relationship between technology and learning outcomes is both psychological and dynamic. Overall, the findings demonstrate that technology-supported English language learning creates a more reflective, participatory, and outcome-oriented environment, positioning engagement and motivation as transformative factors in enhancing the quality of language learning in the digital era.

Although this research makes a significant contribution to the theoretical and practical development of Technology-Enhanced Language Learning (TELL), several limitations should be acknowledged for future research. First, the study used a quantitative questionnaire-based approach involving 300 respondents from two countries, which limits the diversity of cultural and institutional contexts represented. Future studies should consider adopting a mixed-method approach to gain deeper insights into the dynamics of motivation and engagement across different learning environments. Second, the research model focuses on four main constructs: TDI, ENG, MOT, and OUT, while other potential factors such as teacher digital competence, learning satisfaction, and technological self-efficacy may further strengthen the conceptual framework. Therefore, subsequent studies are encouraged to explore the interrelationships among these additional variables within AI-driven learning environments or immersive technologies such as augmented reality (AR) and virtual reality (VR), which could broaden the understanding of future language learning experiences.

From a theoretical perspective, this study contributes to the global literature by introducing a dual psychological mediation model that explains how technology-mediated interaction transforms learning behavior into measurable academic achievement. From a practical perspective, the findings provide strategic insights for educators and curriculum designers to develop English language learning ecosystems that are more student-centered, motivationally engaging, and sustainable amid the continuous transformation of digital education.

ACKNOWLEDGMENTS

The authors would like to express their sincere gratitude to the participating institutions in Pakistan and Indonesia for their valuable cooperation and support throughout the data collection process. Special thanks are extended to the English language learners who contributed their time and insights to this research. The authors also acknowledge the constructive feedback from peer reviewers and academic colleagues, which greatly improved the quality and clarity of this study.

REFERENCES

Adel, A. (2024). The Convergence of Intelligent Tutoring, Robotics, and IoT in Smart Education for the Transition from Industry 4.0 to 5.0. *Smart Cities*, *7*(1), 325–369. https://doi.org/10.3390/smartcities7010014

Akram, H., Abdelrady, A. H., Al-Adwan, A. S., & Ramzan, M. (2022). Teachers' Perceptions of Technology Integration in Teaching-Learning Practices: A Systematic Review. *Frontiers in Psychology*, *13*. https://doi.org/10.3389/fpsyg.2022.920317

Al-Adwan, A. S., Li, N., Al-Adwan, A., Abbasi, G. A., Albelbisi, N. A., & Habibi, A. (2023). "Extending the Technology Acceptance Model (TAM) to Predict University Students' Intentions to Use Metaverse-Based Learning Platforms". *Education and Information Technologies*, *28*(11), 15381–15413. https://doi.org/10.1007/s10639-023-11816-3

Al-Bahadli, K. H., Al-Obaydi, L. H., & Pikhart, M. (2023). The Impact of the Online Project-Based Learning on Students' Communication, Engagement, Motivation, and Academic Achievement. *PSYCHOLINGUISTICS*, *33*(2), 217–237. https://doi.org/10.31470/2309-1797-2023-33-2-217-237

Alam, A., & Mohanty, A. (2023). Educational technology: Exploring the convergence of technology and pedagogy through mobility, interactivity, AI, and learning tools. *Cogent Engineering*, *10*(2). https://doi.org/10.1080/23311916.2023.2283282

Alharbi, M. S. (2025). Digital transformation and EFL anxiety: A mixed-methods study on the impact of online learning on the language acquisition psychology of Saudi Arabian students. *Social Sciences & Humanities Open*, *12*, 101721. https://doi.org/10.1016/j.ssaho.2025.101721

Alkhudiry, R. (2022). The Contribution of Vygotsky's Sociocultural Theory in Mediating L2 Knowledge

Co-Construction. *Theory and Practice in Language Studies*, *12*(10), 2117–2123. https://doi.org/10.17507/tpls.1210.19

Asad, M. M., Hussain, N., Wadho, M., Khand, Z. H., & Churi, P. P. (2021). Integration of e-learning technologies for interactive teaching and learning process: an empirical study on higher education institutes of Pakistan. *Journal of Applied Research in Higher Education*, *13*(3), 649–663. https://doi.org/10.1108/JARHE-04-2020-0103

Bui, T. H. (2022). English teachers' integration of digital technologies in the classroom. *International Journal of Educational Research Open*, *3*, 100204. https://doi.org/10.1016/j.ijedro.2022.100204

Dilekçi, A., & Karatay, H. (2023). The effects of the 21st century skills curriculum on the development of students' creative thinking skills. *Thinking Skills and Creativity*, *47*(March), 101229. https://doi.org/10.1016/j.tsc.2022.101229

Dong, D. (2025). Self-determination theory perspectives on the influence of digital learning engagement on motivation in extracurricular learning activities: Considering the mediating role of digital self-efficacy. *Learning and Motivation*, *90*, 102135. https://doi.org/10.1016/j.lmot.2025.102135

Fang, X., Ng, D. T. K., Leung, J. K. L., & Xu, H. (2024). The applications of the ARCS model in instructional design, theoretical framework, and measurement tool: a systematic review of empirical studies. *Interactive Learning Environments*, *32*(10), 5919–5946. https://doi.org/10.1080/10494820.2023.2240867

Guay, F. (2022). Applying Self-Determination Theory to Education: Regulations Types, Psychological Needs, and Autonomy Supporting Behaviors. *Canadian Journal of School Psychology*, *37*(1), 75–92. https://doi.org/10.1177/08295735211055355

Guo, P., Jeyaraj, J. J., & Razali, A. B. (2024). A systematic review of collaborative mobile-assisted language learning (C-MALL) practices using bibliometric, content, and scientometric analyses. *Humanities and Social Sciences Communications*, *11*(1), 1435. https://doi.org/10.1057/s41599-024-03940-3

Han, F., Ellis, R. A., & Pardo, A. (2022). The Descriptive Features and Quantitative Aspects of Students' Observed Online Learning: How Are They Related to Self-Reported Perceptions and Learning Outcomes? *IEEE Transactions on Learning Technologies*, *15*(1), 32–41. https://doi.org/10.1109/TLT.2022.3153001

He, J., Wang, Q., & Lee, H. (2025). Enhancing online learning engagement: teacher support, psychological needs satisfaction and interaction. *BMC Psychology*, *13*(1), 696. https://doi.org/10.1186/s40359-025-03016-0

Hidayat, D. N., Lee, J. Y., Mason, J., & Khaerudin, T. (2022). Digital technology supporting English learning among Indonesian university students. *Research and Practice in Technology Enhanced Learning*, *17*(1), 23. https://doi.org/10.1186/s41039-022-00198-8

Hidayati, D., & Slamet, J. (2025). Interactive Multimedia via LMS on a Reading Comprehension Course: Enhancing Engagement and Learning Outcomes in Islamic Higher Education. *Journal of Studies in the English Language*, *20*(1), 95–122. https://doi.org/10.64731/jsel.v20i1.277426

Hossain, K. I. (2024). Reviewing the role of culture in English language learning: Challenges and opportunities for educators. *Social Sciences & Humanities Open*, *9*, 100781. https://doi.org/10.1016/j.ssaho.2023.100781

Huang, F., & Derakhshan, A. (2025). Learning Motivation and Digital Literacy in AI Adoption for Self-Regulated English Learning. *European Journal of Education*, *60*(4). https://doi.org/10.1111/ejed.70254

Huang, L., Tian, F., & Li, F. (2025). Teaching styles and sports engagement: mediation by satisfaction and resilience in Chinese adolescents. *Frontiers in Psychology*, *16*. https://doi.org/10.3389/fpsyg.2025.1630300

Huang, X., Ruiz-Segura, A., Tan, C., Wang, T., Sharma, R., & Lajoie, S. P. (2023). Social presence in technology-rich learning environments: how real we are feeling connected and how does it matter for learning? *Information and Learning Sciences*, *124*(11/12), 396–424. https://doi.org/10.1108/ILS-04-2023-0034

Hwang, G.-J., & Chang, C.-C. (2025). A self-determination theory-based digital gaming approach to enhancing EFL learners' competence in applying professional English. *Educational Technology Research and Development*, *73*(2), 1205–1223. https://doi.org/10.1007/s11423-024-10445-y

Ibrohim, I., Purwaningsih, E., Munzil, M., Hidayanto, E., Sudrajat, A. K., Saefi, M., & Hassan, Z. bin. (2022). Possible links between Indonesian science teacher's TPACK perception and demographic factors: Self-reported survey. *Eurasia Journal of Mathematics, Science and Technology Education*, *18*(9), em2146. https://doi.org/10.29333/ejmste/12282

Jiang, Y., Yue, S., & Mantou Lou, N. (2024). Exploring the motivational mechanisms of growth beliefs on perseverance among EFL students: The role of ideal and ought-to L2 selves. *International Journal of Applied Linguistics*, *34*(4), 1335–1351. https://doi.org/10.1111/ijal.12572

Jin, S.-H., Im, K., Yoo, M., Roll, I., & Seo, K. (2023). Supporting students' self-regulated learning in online learning using artificial intelligence applications. *International Journal of Educational Technology*

in Higher Education, *20*(1), 37. https://doi.org/10.1186/s41239-023-00406-5

Karakaya, K., & Bozkurt, A. (2022). Mobile-assisted language learning (MALL) research trends and patterns through bibliometric analysis: Empowering language learners through ubiquitous educational technologies. *System*, *110*, 102925. https://doi.org/10.1016/j.system.2022.102925

Kline, R. B. (2023). *Principles and practice of structural equation modeling*. Guilford publications.

Koukaras, C., Koukaras, P., Ioannidis, D., & Stavrinides, S. G. (2025). AI-Driven Telecommunications for Smart Classrooms: Transforming Education Through Personalized Learning and Secure Networks. *Telecom*, *6*(2), 21. https://doi.org/10.3390/telecom6020021

Labrović, J. A., Petrović, N., Anđelković, J., & Meršnik, M. (2025). Patterns of behavioral engagement in an online english language course: cluster analysis. *Journal of Computing in Higher Education*, *37*(1), 1–26. https://doi.org/10.1007/s12528-023-09382-1

Lampropoulos, G., & Sidiropoulos, A. (2024). Impact of Gamification on Students' Learning Outcomes and Academic Performance: A Longitudinal Study Comparing Online, Traditional, and Gamified Learning. *Education Sciences*, *14*(4), 367. https://doi.org/10.3390/educsci14040367

Li, S., & Lajoie, S. P. (2022). Cognitive engagement in self-regulated learning: an integrative model. *European Journal of Psychology of Education*, *37*(3), 833–852. https://doi.org/10.1007/s10212-021-00565-x

Liu, G. (2025). To Transform or Not to Transform? Understanding the Digital Literacies of Rural Lower-Class EFL Learners. *Journal of Language, Identity & Education*, *24*(4), 928–945. https://doi.org/10.1080/15348458.2023.2236217

Liu, Q., Du, X., & Lu, H. (2023). Teacher support and learning engagement of EFL learners: The mediating role of self-efficacy and achievement goal orientation. *Current Psychology*, *42*(4), 2619–2635. https://doi.org/10.1007/s12144-022-04043-5

Mhlongo, S., Mbatha, K., Ramatsetse, B., & Dlamini, R. (2023). Challenges, opportunities, and prospects of adopting and using smart digital technologies in learning environments: An iterative review. *Heliyon*, *9*(6), e16348. https://doi.org/10.1016/j.heliyon.2023.e16348

Mohammadi Zenouzagh, Z., Admiraal, W., & Saab, N. (2023). Learner autonomy, learner engagement and learner satisfaction in text-based and multimodal computer mediated writing environments. *Education and Information Technologies*, *28*(11), 14283–14323. https://doi.org/10.1007/s10639-023-11615-w

Muhria, L., Kurnihayati, K., Solihin, R. K., & Sundari, F. D. (2025). Digital-Assisted Direct Reading Approach: Strengthening Student Engagement and Motivation in English Learning. *Journal of Society and Development*, *5*(1), 76–81. https://doi.org/10.57032/jsd.v5i1.305

Namaziandost, E., Çakmak, F., Heydarnejad, T., & Rezai, A. (2024). The predictive effects of learner autonomy and academic engagement on willingness to communicate, foreign language learning self-esteem, and L2 grit in an EFL context. *Acta Psychologica*, *250*, 104528. https://doi.org/10.1016/j.actpsy.2024.104528

Nisak, S. K. (2024). Optimizing Interactive Learning Management System (LMS) in Improving Students' English Language Skills. *Zabags International Journal of Education*, *2*(2), 66–74. https://doi.org/10.61233/zijed.v2i2.21

Nurhikmah H, Ramli, A. M., Sujarwo, Bena, B. A., Arwadi, F., Syawaluddin, A., & Dedikasi Malik Nur, I. (2024). Teachers' Readiness in Online Learning: Digital Literacy-Self-Efficacy, Pedagogical Competence, Attitude, Infrastructure, and Management Support. *Electronic Journal of E-Learning*, *22*(8), 93–105. https://doi.org/10.34190/ejel.22.8.3358

Ouyang, R.-G., Long, Y., Zhang, J.-Q., & Cao, Z. (2023). Interventions for improving self-efficacy in patients after stroke based on self-efficacy-related principles of Bandura's cognition theory: a systematic review and meta-analysis. *Topics in Stroke Rehabilitation*, *30*(8), 820–832. https://doi.org/10.1080/10749357.2023.2172832

Pan, X. (2022). Exploring the multidimensional relationships between educational situation perception, teacher support, online learning engagement, and academic self-efficacy in technology-based language learning. *Frontiers in Psychology*, *13*. https://doi.org/10.3389/fpsyg.2022.1000069

Pramesworo, I. S., Sembiring, D., Sarip, M., Lolang, E., & Fathurrochman, I. (2023). Identification of New Approaches to Information Technology-Based Teaching for Successful Teaching of Millennial Generation Entering 21st Century Education. *Jurnal Iqra' : Kajian Ilmu Pendidikan*, *8*(1), 350–370. https://doi.org/10.25217/ji.v8i1.2722

Qi, S., & Derakhshan, A. (2025). Technology-based collaborative learning: EFL learners' social regulation and modifications in their academic emotions and academic performance. *Education and Information Technologies*, *30*(7), 8611–8636. https://doi.org/10.1007/s10639-024-13167-z

Quibrantar, S. M., & Ezezika, O. (2023). Evaluating student engagement and experiential learning in global classrooms: A qualitative case study. *Studies in Educational Evaluation*, *78*, 101290. https://doi.org/10.1016/j.stueduc.2023.101290

Rakha, A. H. (2025). Promoting online teaching through active learning strategies: applications and

innovations. *Frontiers in Education*, *10*. https://doi.org/10.3389/feduc.2025.1546208
Rasimin, Semma, A. B., Zakiyuddin, Ali, M., & Helmy, M. I. (2024). Multi-dimensional challenges in the Indonesian social science information technology-based learning: A systematic literature review. *Heliyon*, *10*(7), e28706. https://doi.org/10.1016/j.heliyon.2024.e28706
Rawal, A. P. (2025). Exploring the community of inquiry framework in higher education: a bibliometric analysis. *Cogent Education*, *12*(1). https://doi.org/10.1080/2331186X.2025.2460224
Revishvili, M., & Tsereteli, M. (2024). The psychological mechanism of self-regulated learning in a technology-enhanced environment. *Cogent Education*, *11*(1). https://doi.org/10.1080/2331186X.2024.2372153
Rintaningrum, R. (2023). Technology integration in English language teaching and learning: Benefits and challenges. *Cogent Education*, *10*(1). https://doi.org/10.1080/2331186X.2022.2164690
Sain, Z. H., Thelma, C. C., & Sain, S. H. (2025). Tech-Driven Teaching: Analyzing Academic Research on Educational Integration of Technology. *International Journal of Higher Education Management*, *11*(1). https://doi.org/10.24052/IJHEM/V11N01/ART-1
Shadiev, R., & Yu, J. (2024). Review of research on computer-assisted language learning with a focus on intercultural education. *Computer Assisted Language Learning*, *37*(4), 841–871. https://doi.org/10.1080/09588221.2022.2056616
Shah, M. A. (2022). Teachers as Reflective Practitioners: From Individualism to Vygotskian Social Constructivism. *Alberta Journal of Educational Research*, *68*(3), 297–307. https://doi.org/10.55016/ojs/ajer.v68i3.68598
Shea, P., Richardson, J., & Swan, K. (2022). Building bridges to advance the Community of Inquiry framework for online learning. *Educational Psychologist*, *57*(3), 148–161. https://doi.org/10.1080/00461520.2022.2089989
Strielkowski, W., Grebennikova, V., Lisovskiy, A., Rakhimova, G., & Vasileva, T. (2024). AI-driven adaptive learning for sustainable educational transformation. *Sustainable Development*. https://doi.org/10.1002/sd.3221
Teng, Y., & Wang, X. (2021). The effect of two educational technology tools on student engagement in Chinese EFL courses. *International Journal of Educational Technology in Higher Education*, *18*(1), 27. https://doi.org/10.1186/s41239-021-00263-0
Thornhill-Miller, B., Camarda, A., Mercier, M., Burkhardt, J.-M., Morisseau, T., Bourgeois-Bougrine, S., Vinchon, F., El Hayek, S., Augereau-Landais, M., Mourey, F., Feybesse, C., Sundquist, D., & Lubart, T. (2023). Creativity, Critical Thinking, Communication, and Collaboration: Assessment, Certification, and Promotion of 21st Century Skills for the Future of Work and Education. *Journal of Intelligence*, *11*(3), 54. https://doi.org/10.3390/jintelligence11030054
Wang, C., Chen, X., Yu, T., Liu, Y., & Jing, Y. (2024). Education reform and change driven by digital technology: a bibliometric study from a global perspective. *Humanities and Social Sciences Communications*, *11*(1), 256. https://doi.org/10.1057/s41599-024-02717-y
Wang, J., Tigelaar, D. E. H., Zhou, T., & Admiraal, W. (2023). The effects of mobile technology usage on cognitive, affective, and behavioural learning outcomes in primary and secondary education: A systematic review with meta-analysis. *Journal of Computer Assisted Learning*, *39*(2), 301–328. https://doi.org/10.1111/jcal.12759
Wang, Q., & Xue, M. (2022). The implications of expectancy-value theory of motivation in language education. *Frontiers in Psychology*, *13*. https://doi.org/10.3389/fpsyg.2022.992372
Wibowo, G. A., Karim, A. A., Hasan, S. H., & Ruhimat, M. (2023). Use of Technology in Active Learning: Increasing Student Interaction and Engagement. *Al-Hijr: Journal of Adulearn World*, *2*(4), 271–293. https://doi.org/10.55849/alhijr.v2i4.539
Wibowo, S., Wangid, M. N., & Firdaus, F. M. (2025). The relevance of Vygotsky's constructivism learning theory with the differentiated learning primary schools. *Journal of Education and Learning (EduLearn)*, *19*(1), 431–440. https://doi.org/10.11591/edulearn.v19i1.21197
Wu, Z., & Huang, R. (2025). The impact of digital transformation on the quality of college English teaching: the mediating role of teachers' support. *Asia Pacific Journal of Education*, 1–17. https://doi.org/10.1080/02188791.2025.2467941
Yahiaoui, F., Aichouche, R., Chergui, K., Brika, S. K. M., Almezher, M., Musa, A. A., & Lamari, I. A. (2022). The Impact of e-Learning Systems on Motivating Students and Enhancing Their Outcomes During COVID-19: A Mixed-Method Approach. *Frontiers in Psychology*, *13*. https://doi.org/10.3389/fpsyg.2022.874181
Yousefi, M., & Mahmoodi, M. H. (2022). The L2 motivational self-system: A meta-analysis approach. *International Journal of Applied Linguistics*, *32*(2), 274–294. https://doi.org/10.1111/ijal.12416
Zamir, S., & Wang, Z. (2023). Uncovering Covid-19, distance learning, and educational inequality in rural areas of Pakistan and China: a situational analysis method. *Humanities and Social Sciences Communications*, *10*(1), 679. https://doi.org/10.1057/s41599-023-02025-x
Zhang, Yating, & Miao, Z. (2025). Enhancing EFL Learners' Engagement and Motivation Through Immersive Technologies: The Role of Artificial Intelligence, Augmented Reality, Virtual Reality,

and Mobile Applications. *European Journal of Education*, *60*(2). https://doi.org/10.1111/ejed.70128

Zhang, Yue, & Liu, G. L. (2025). Examining the impacts of learner backgrounds, proficiency level, and the use of digital devices on informal digital learning of English: an explanatory mixed-method study. *Computer Assisted Language Learning*, *38*(5–6), 1113–1140. https://doi.org/10.1080/09588221.2023.2267627

Zhao, J., Li, X., & Liao, H. (2025). Effect of L2 motivation on use behavior of translation technologies among English-related majors: Mediating effects of performance expectancy and L2 grit. *Language Teaching Research*. https://doi.org/10.1177/13621688251352261

Zou, Y., Kuek, F., Feng, W., & Cheng, X. (2025). Digital learning in the 21st century: trends, challenges, and innovations in technology integration. *Frontiers in Education*, *10*. https://doi.org/10.3389/feduc.2025.1562391