Revolutionizing language education: How advanced technologies in Technology-Assisted Language Learning (TALL) are transforming teacher-student dynamics and elevating learning outcomes

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ABSTRACT: This study investigates the interrelationships among pedagogies in Technology-Assisted Language Learning, teacher-student dynamics, and perceptions of learning outcomes within the context of English as a Foreign Language education. Utilizing a quantitative approach, we conducted a structural equation modeling analysis to explore these relationships among 834 EFL students. The findings reveal strong positive correlations between pedagogies and teacher-student dynamics, and between teacher-student dynamics and learning outcomes. Furthermore, pedagogies significantly predicts both teacher-student dynamics, and perceptions of learning outcomes. SPSS version 27 and AMOS version 24 were used for data analysis. The results indicate that effective technology integration and innovative pedagogical practices not only enhance teacher-student interactions but also foster positive perceptions of learning outcomes among students. These findings underscore the critical role of engaging and supportive learning environments in improving educational experiences. The study contributes to the field by providing empirical evidence that emphasizes the need for educators to adopt robust pedagogies in Technology-Assisted Language Learning strategies to optimize both interpersonal relationships and academic success. Future research should explore the long-term effects of TALL and investigate the influence of demographic variables on these relationships to further enhance our understanding of technology's role in language education.
Keywords: Learning outcomes, Pedagogical approaches, Student engagement, Teacher-student dynamics, Technology-assisted language learning

Revolución de la enseñanza de idiomas: Cómo las tecnologías avanzadas en el Aprendizaje de Idiomas Asistido por Tecnologías (TALL) están transformando la dinámica profesor - alumno y mejorando los resultados del aprendizaje

RESUMEN: Este estudio investiga las interrelaciones entre las pedagogías en el Aprendizaje de Idiomas Asistido por Tecnologías (TALL), la dinámica profesor - alumno y las percepciones de los resultados del aprendizaje en el contexto de la enseñanza del inglés como lengua extranjera. Utilizando un enfoque cuantitativo, realizamos un análisis de modelado de ecuaciones estructurales para explorar estas relaciones entre los estudiantes de inglés como

lengua extranjera. Los hallazgos revelan fuertes correlaciones positivas entre las pedagogías y la dinámica profesor - alumno, y entre la dinámica profesor - alumno y los resultados del aprendizaje. Además, las pedagogías predicen significativamente tanto la dinámica profesor - alumno como las percepciones de los resultados del aprendizaje. Los resultados indican que la efectiva integración de la tecnología y las prácticas pedagógicas innovadoras no solo mejoran las interacciones profesor - alumno, sino que también fomentan las percepciones positivas de los resultados del aprendizaje entre los estudiantes. Estos hallazgos subrayan el papel fundamental de los entornos de aprendizaje atractivos y de apoyo en la mejora de las experiencias educativas. El estudio contribuye al campo por proporcionar evidencia empírica que subraya la necesidad de que los educadores adopten pedagogías sólidas en las estrategias de Aprendizaje de Idiomas Asistido por Tecnologías para optimizar tanto las relaciones interpersonales como el éxito académico. Las futuras investigaciones deben explorar los efectos a largo plazo del TALL e investigar la influencia de las variables demográficas en estas relaciones para profundizar en nuestro conocimiento del papel de la tecnología en la enseñanza de idiomas.
Palabras clave: Aprendizaje de idiomas asistido por tecnologías, Dinámica profesor - alumno, Enfoques pedagógicos, Resultados del aprendizaje, Compromiso de los estudiantes.

1. Introduction

The advent of advanced technologies has fundamentally transformed various sectors, and education is no exception. Among the most impactful areas of change is language education, where Technology-Assisted Language Learning (TALL) is redefining traditional pedagogical methods (Liu & Wang, 2024; Rodríguez-Ferrer et al., 2024; Xin & Derakhshan, 2025; Zhi & Wang, 2024). TALL encompasses a range of innovative tools and platforms that facilitate language learning and teaching, harnessing the power of digital resources to enhance educational experiences (Dai & Wang, 2024; Wang & Xue, 2024). As language learners increasingly interact with technology—ranging from language learning apps to virtual classrooms and artificial intelligence—the dynamics between teachers and students are evolving in unprecedented ways (Bahari, 2022; Guo & Wang, 2024). This transformation is characterized by a shift from traditional instructor-led models to more interactive, student-centered approaches that allow for personalized learning pathways (Huang et al., 2024; Liu & Wang, 2024). Advanced technologies enable educators to tailor their instruction to meet the diverse needs and preferences of learners, fostering engagement and motivation. Furthermore, these tools equip students with greater autonomy, enabling them to take charge of their language acquisition journey (Tang et al., 2024; Wong et al., 2011).

In the rapidly evolving landscape of education, particularly in the domain of language acquisition, the integration of technology has emerged as a pivotal factor influencing both teaching methodologies and student experiences (Derakhshan & Ghiasvand, 2024). As English as a Foreign Language (EFL) education increasingly adopts Technology-Assisted Language Learning (TALL) approaches, understanding the implications of these pedagogical shifts on key aspects such as teacher-student dynamics and students' perceptions of learning outcomes has become imperative (Bahari, 2023). Despite the growing incorporation of technology into language learning environments, there remains a critical gap in empirical research exploring how these technological pedagogies impact the relational dynamics between EFL teachers and students. Specifically, the nature of these interactions—whether they foster collaborative learning, enhance communication, or create barriers to engagement—requires further inves-

tigation. Additionally, the perceptions that students form regarding their learning outcomes within technologically enhanced environments may significantly influence their motivation and overall success in acquiring a new language (Shao, 2020).

The significance of this correlational study lies in its potential to enhance our understanding of Technology-Assisted Language Learning (TALL) within the context of English as a Foreign Language (EFL) education. As technology continues to play an increasingly pivotal role in educational settings, it becomes essential to investigate its impact on both teaching methodologies and student learning outcomes. By exploring how EFL students' pedagogies in TALL influence teacher-student interactions, this study aims to provide insights into creating more effective and positive learning environments (Derakhshan et al., 2024; Rodríguez-Ferrer et al., 2024). Understanding these dynamics can help educators adopt strategies that foster collaboration, engagement, and mutual respect, ultimately enriching the educational experience. Identifying significant relationships between technology-assisted pedagogies and learning outcomes can inform educators about best practices in TALL. This knowledge can empower teachers to design instructional approaches that leverage technology in ways that enhance student motivation, participation, and success in language acquisition (Bahari, 2023; Pan & Wang, 2025). The study seeks to delve into EFL students' perceptions of their learning outcomes in technology-enhanced environments (Qi & Derakhshan, 2025; Tang et al., 2024). Insights into these perceptions can assist educators in recognizing the factors that contribute to or detract from students' learning experiences, allowing for the refinement of instructional strategies. The findings can guide curriculum designers and policymakers in integrating technology into language education more effectively. By understanding the predictive relationships between pedagogies and learning dynamics, stakeholders can develop programs that align technological tools with pedagogical goals, enhancing educational outcomes.

2. Review of the literature

As the landscape of education evolves with the integration of advanced technologies, understanding the implications of these changes on teaching and learning dynamics becomes increasingly critical (Wu et al., 2024). The first section will explore the theoretical foundations of TALL, including relevant models and frameworks that illustrate how technology can support language learning. Following this, the review will focus on the specific pedagogies employed in TALL and their effectiveness in enhancing teacher-student interactions. Additionally, the perceptions of EFL students regarding their learning experiences within technology-enhanced environments will be addressed, highlighting how these perceptions influence their overall educational outcomes (Bahari, 2022).

Constructivism posits that learners construct knowledge through experiences and interactions with their environment. This theory emphasizes the importance of learner agency and social interaction in the learning process. In the context of TALL, technology serves as a tool that facilitates collaborative learning experiences, allowing students to engage meaningfully with both content and their peers (Wong et al., 2011). This approach underscores the significance of student-centered pedagogies, wherein learners actively participate in their educational journeys, leading to enhanced teacher-student dynamics. Technology Acceptance Model (TAM) explores how users come to accept and use technology. According to TAM,

perceived ease of use and perceived usefulness significantly influence users' attitudes toward technology adoption. In TALL contexts, understanding students' perceptions of technology's usefulness for language learning can provide insights into how these perceptions impact their engagement and, consequently, their learning outcomes (Abraham et al., 2022). Various pedagogical approaches, such as blended learning and flipped classrooms, illustrate how technology can alter the traditional classroom dynamic. These methods encourage active participation and collaboration, promoting a more interactive relationship between teachers and students. By investigating EFL students' pedagogies in TALL, the study aims to evaluate the efficacy of these approaches in fostering positive learning experiences. The theoretical frameworks outlined above provide a comprehensive understanding of the multifaceted relationships between EFL students' pedagogies in TALL, teacher-student dynamics, and perceptions of learning outcomes (Shao, 2020).

2.1. Empirical studies

Outlaw and Grifenhagen (2024) examined the impact of mobile-assisted language learning (MALL) on students' language proficiency and motivation in an EFL context. It highlighted significant improvements in engagement and positive shifts in teacher-student dynamics, emphasizing how technology fosters active learning and collaboration. Yan et al. (2024) explored the effectiveness of blended learning environments on EFL students' performance and perceptions of learning outcomes. The findings indicated that students in blended learning settings reported enhanced teacher-student interactions and a more significant sense of agency in their learning processes. Sadan et al. (2024) focused on the relationships between EFL students' perceptions of technology integration in language learning and their collaborative skills. It found that positive perceptions of technology use were linked to improved teacher-student communication and a more supportive learning atmosphere, which, in turn, positively affected learning outcomes. Renuga Devi et al. (2024) assessed the role of gamification in technology-assisted language learning. The research revealed that gamified elements significantly enhanced engagement levels among EFL students, leading to improved teacher-student dynamics and higher perceptions of learning effectiveness. Davies et al. (2024) explored the predictive relationship between students' technology usage and their emotional regulation in language learning contexts. The results highlighted how effective technology integration not only influenced teacher-student relationships but also enhanced students' perceptions of their learning outcomes, leading to greater motivation and academic success. These studies collectively emphasize the importance of technology in enhancing pedagogical practices, improving teacher-student dynamics, and ultimately elevating EFL students' learning experiences and outcomes.

Many studies, particularly those utilizing convenience sampling or limited geographical contexts, may face criticism regarding the generalizability of their results (Davies et al., 2024; Sadan et al., 2024; Tang et al., 2024). For instance, findings from a specific culture or educational system may not apply universally, raising questions about the applicability of TALL strategies across diverse educational settings (Abraham et al., 2022). Research focusing on TALL often assumes that all students have equal access to technology, which is not always the case. This can lead to biases in findings, as students from underprivileged

backgrounds may not benefit from technology-enhanced learning experiences. This issue highlights the digital divide and raises ethical considerations regarding equitable access to educational resources (Rodríguez-Ferrer et al., 2024). The diverse methodologies used to assess learning outcomes can lead to inconsistency in results. Some studies may focus solely on quantitative measures (like test scores), while others may emphasize qualitative feedback (like student surveys). This disparity raises questions about the validity and reliability of comparing outcomes across different studies and the holistic understanding of learning (Tang et al., 2024). The success of TALL heavily depends on teachers' proficiency and comfort with using technology. Some studies may overlook the crucial aspect of teacher training and support, leading to an incomplete view of the pedagogical dynamics. Without addressing how teachers adapt to and incorporate technology, the findings may inadvertently minimize the challenges educators face in these environments (Wu et al., 2024). Some critics argue that a strong focus on technology can overshadow essential pedagogical principles and traditional instructional strategies. While TALL can enhance learning experiences, an overemphasis might lead to neglecting effective face-to-face communication and interpersonal skills, which are crucial in language learning (Yan et al., 2024). By recognizing these controversial issues, future research can adopt more nuanced approaches that address these challenges, providing a richer and more comprehensive understanding of the dynamics between technology, pedagogy, and learning outcomes in EFL contexts.

To guide the investigation, the following research questions were formulated, aligning with the study's objectives and theoretical framework.

RQ1. Is there any significant relationship between EFL students' pedagogies in technology-assisted language learning and their teacher-student dynamics and perceptions of learning outcomes?

RQ2. To what extent do EFL students' pedagogies in technology-assisted language learning predict their teacher-student dynamics and perceptions of learning outcomes?

3. Method

3.1. Participants

The study included a total of 834 valid questionnaires. Among the participants, 345 were males (41.37%), and 489 were females (58.63%). In terms of grades, 486 were freshmen (58.27%), 215 were sophomores (25.78%), 94 were juniors (11.27%), and 29 were seniors (4.68%). Regarding their majors, 168 participants (20.14%) were English majors, while the remaining 666 participants (79.86%) were non-English majors. At the beginning of the study, the purpose and process of the survey were explained to the participants. In addition, the participants were assured that their identities and responses would remain private and confidential.

Table 1. *Participants' demographic information*

Demographics	Frequency (%)
Gender	
Male	345 (41.37%)
Female	489 (58.63%)
Grade	
Freshmen	486 (58.27%)
Sophomores	215 (25.78%)
Juniors	94 (11.27%)
Seniors	29 (4.68%)
Major	
English	168 (20.14%)
Non-English	666 (79.86%)

3.2. Instruments

3.2.1. Pedagogies in technology-assisted language learning questionnaire

The questionnaire is a comprehensive instrument designed to evaluate the effectiveness of pedagogical strategies in technology-enhanced language learning contexts (Abraham et al., 2022). The questionnaire consists of 20 items divided into five dimensions: instructional design, learner engagement, assessment and feedback, teacher's role and facilitation, and accessibility and usability. The PTALL questionnaire demonstrates robust construct validity, as confirmed through confirmatory factor analysis (CFA). Each of the five dimensions has high factor loadings (above 0.7), indicating that the items effectively measure their intended constructs. The questionnaire shows strong convergent validity, with an Average Variance Extracted (AVE) greater than 0.5 for each dimension. This indicates that the items within each construct share a significant amount of variance. The AVE values for each construct are greater than their Maximum Shared Variance (MSV), confirming that the dimensions are distinct and measure separate aspects of pedagogical strategies. Reliability testing using Cronbach's alpha reveals values above 0.85 for all dimensions, further supporting the questionnaire's reliability.

3.2.2. Teacher-student dynamics questionnaire

The questionnaire consists of 15 items designed to assess various aspects of the teacher-student relationship (Pennings et al., 2014). The questionnaire covers the following dimensions: communication and interaction, emotional connection, role modeling and leadership, and student autonomy and empowerment. The validity of the TSDQ is typically assessed. Its content validity is ensured by expert reviews of the questionnaire, making sure the 15 items comprehensively cover the four dimensions related to teacher-student dynamics. Its construct validity is verified through factor analysis, confirming that the items cluster into the four intended dimensions: communication, emotional connection, role modeling, and student

autonomy. The reliability of the TSDQ is tested through internal consistency, measured using Cronbach's alpha, which should ideally exceed 0.7, indicating that the items within each dimension are consistently measuring the same construct.

3.2.3. Perceptions of learning outcomes questionnaire

The questionnaire consists of 20 items designed to assess students' perceptions of their learning outcomes in various domains (Kember & Leung, 2009). The questionnaire is divided into the following four dimensions: academic achievement, personal and social development, cognitive and metacognitive skills, and emotional and affective outcomes. The content validity validity is ensured by having experts or educators review the items to confirm that the 20 questions effectively cover the four intended dimensions of learning outcomes. This process ensures the instrument captures relevant aspects of academic achievement, personal development, cognitive/metacognitive skills, and emotional outcomes. The construct validity is confirmed through factor analysis, which tests whether the items on the questionnaire indeed align with the theoretical constructs of the four dimensions. The goal is to ensure that each dimension is accurately represented and distinct from the others. Cronbach's alpha is used to measure internal consistency, ensuring that the items within each dimension reliably measure the same construct. A Cronbach's alpha coefficient above 0.7 for each of the four dimensions would indicate good internal consistency.

3.3. Data collection procedure

The questionnaire was structured into two distinct sections. The first part collected essential demographic information from students, such as age, gender, academic background, and level of experience with Technology-Assisted Language Learning (TALL). This information was vital for understanding the diversity of the sample and contextualizing the responses in relation to different student groups. The second part of the questionnaire delved into students' opinions and perceptions regarding various aspects of TALL. Specifically, it explored their views on pedagogical strategies used in TALL environments, the dynamics of teacher-student interactions within these settings, and their perceptions of the learning outcomes associated with TALL. The second section aimed to capture a comprehensive understanding of students' experiences and attitudes toward the use of technology in language learning, highlighting the strengths and challenges they encountered in such settings. The data collection process spanned a period of two weeks and was conducted through Wenjuanxing, an online survey platform. This digital approach facilitated efficient distribution and response collection, making it accessible to a large number of participants across different regions. The survey garnered a total of 834 valid responses, representing a significant sample size that provided a solid foundation for analyzing the perceptions of language learners. For this study, convenience sampling was employed, where participants were selected based on their availability and willingness to participate in the survey. This method allowed for a practical and efficient approach to data collection, though it may introduce potential biases related to the self-selection of respondents. Despite this, the large number of valid responses helped mitigate such biases and ensured that the sample was diverse enough to draw meaningful

conclusions. Confidentiality and ethical considerations were paramount throughout the data collection process. Participants were informed of the purpose of the study and assured that their responses would be kept confidential. No personally identifiable information was collected beyond the demographic data, and all responses were anonymized to protect the privacy of the students. Additionally, students were provided with an informed consent form outlining the voluntary nature of participation and their right to withdraw at any time without consequence. These measures helped ensure that the study adhered to ethical standards and maintained the integrity of the data.

3.4. Data analysis

For the data analysis process, the research team utilized SPSS (version 27) and AMOS (version 24), both well-established statistical software tools. SPSS was employed to produce descriptive statistics, conduct correlation analyses, and perform regression analysis, enabling the researchers to examine relationships and patterns within the data. These analyses offered insights into the primary variables and their interconnections, which were essential for understanding the dynamics of the study. In addition to the foundational statistical techniques, AMOS was used for structural equation modeling (SEM), which provided a more advanced exploration of the intricate relationships between the study's variables. SEM is a robust method that allows for the modeling of both direct and indirect effects, providing a clearer understanding of the interactions between various factors. The team also employed advanced techniques such as factor analysis to streamline the dataset and identify the key underlying constructs driving the observed patterns. These analytical approaches were instrumental in confirming the research hypotheses, uncovering significant relationships among variables, and offering valuable insights into learning motivation, cognitive skills, and creativity in the context of computer science and robotics education. Before the data collection, participants were thoroughly briefed on the study's primary objectives and the process for completing the questionnaire.

5. Results

The researcher employed Confirmatory Factor Analysis (CFA) to assess the reliability of the surveys and explore the relationships between variables. The results verified that the observed variables corresponded to the theoretical constructs, confirming their uniqueness and connections. Convergent validity was demonstrated through significant factor loadings, while discriminant validity was determined by comparing the Average Variance Extracted (AVE) with the squared correlations between constructs. Constructs were deemed distinct when the AVE exceeded the squared correlations. The CFA offered a comprehensive evaluation of the variable relationships, with findings presented in tables and figures to support the reliability and validity of the constructs.

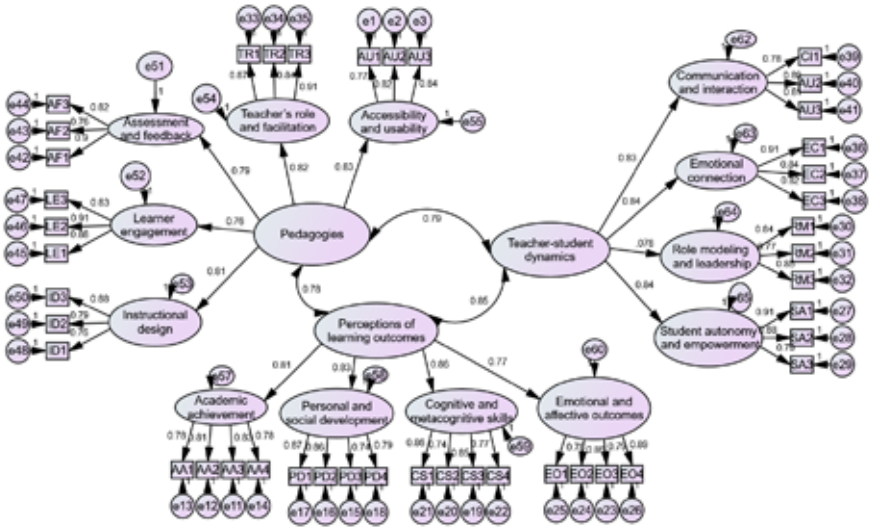

Figure 1. *The final adjusted cfa model with standardized estimates*

The model in Figure 1 confirms robust relationships among pedagogies, teacher-student dynamics, and perceptions of learning outcomes, supported by high factor loadings (≥0.76). The direct path coefficients indicate that both pedagogical practices and teacher-student interactions are vital predictors of students' perceived learning outcomes. Mediation analysis highlights the importance of teacher-student dynamics in maximizing the effectiveness of pedagogical approaches.

Table 2. *The goodness of fit estimation*

		THRESHOLD			
CRITERIA		TERRIBLE	ACCEPTABLE	EXCELLENT	EVALUATION
CMIN	6034.269				
DF	1983				
CMIN/DF	3.043	> 5	> 3	> 1	Acceptable
RMSEA	.077		< .08	< .06	Acceptable
GFI	.958	> .8	> .9	> .95	Acceptable
CFI	.955	> .8	> .9	> .95	Acceptable
PNFI	.642		> .5		Acceptable
TLI	.950	> .8	> .9	> .95	Acceptable

Note: CMIN: Chi-Square Minimum Discrepancy; DF: Degrees of Freedom; CMIN/DF: Chi-Square Minimum Discrepancy divided by Degrees of Freedom; RMSEA: Root Mean Square Error of Approximation; GFI: Goodness of Fit Index; CFI: Comparative Fit Index; PNFI: Parsimony-Adjusted Normed Fit Index; TLI: Tucker-Lewis Index

The model in Table 2 demonstrates an acceptable fit to the data based on the following goodness-of-fit indices. CMIN/DF = 3.043, within the acceptable range of 1 to 3. RMSEA = 0.077, indicating an acceptable fit (< 0.08). GFI = 0.958, slightly below the excellent threshold but within the acceptable range (> 0.90). CFI = 0.955 and TLI = 0.950, both within acceptable thresholds (> 0.90) and close to excellent levels. PNFI = 0.642, surpassing the threshold of 0.5, suggesting adequate parsimony. The SEM model achieves an acceptable fit across most criteria, with some indices nearing excellent levels (e.g., GFI, CFI, and TLI). Improvements in RMSEA could further enhance model fit, but the overall results suggest the model is well-structured and captures the underlying data relationships adequately.

Table 3. *Reliability and validity of the variables*

	CR	AVE	MSV	MaxR(H)	PTALL	TSD	PLO
PTALL	.89	.89	.843	.872	**.932**		
TSD	.91	.87	.833	.853	.673***	**.924**	
PLO	.82	.86	.823	.824	.617***	.711***	**.919**

Note: CR: Composite Reliability; AVE: Average Variance Extracted; MSV: Maximum Shared Variance; MaxR(H): Maximum Reliability (H)
PTALL: Pedagogies in technology-assisted language learning; TSD: Teacher-student dynamics; PLO: Perceptions of learning outcomes
*** It is significant at .000 level

The results in Table 3 indicate that all three constructs demonstrated strong internal consistency, with CR values exceeding 0.8 (PTALL: 0.89, TSD: 0.91, PLO: 0.82). MaxR(H) values further supported the reliability of these constructs. The AVE values for PTALL (0.89), TSD (0.87), and PLO (0.86) indicate excellent convergent validity, as they exceed the threshold of 0.5. MSV values for all constructs (PTALL: 0.843, TSD: 0.833, PLO: 0.823) were below their respective AVE values, confirming discriminant validity. Significant correlations were observed among PTALL, TSD, and PLO, with all relationships significant at the 0.000 level. PTALL and TSD: $r = 0.673$*. TSD and PLO: $r = 0.711$*. PTALL and PLO: $r = 0.617$*. The constructs in the study demonstrated high reliability and validity. All CR and AVE values were well above acceptable thresholds, confirming internal consistency and convergent validity. MSV values below AVE supported discriminant validity, ensuring the constructs measure distinct dimensions. The significant inter-construct correlations highlight theoretical coherence and suggest meaningful relationships between pedagogies, teacher-student dynamics, and perceptions of learning outcomes.

Table 4. *Standardized regression weights of the variables*

			STANDARDIZED REGRESSION WEIGHTS	S.E.	C.R.	P
PTALL	↔	TSD	.791	.125	.367	.001
TSD	↔	PLO	.853	.271	.466	.001
PLO	↔	PTALL	.784	.345	.531	.002

Note: S.E.: Standard Error; C.R.: Critical Ratio; P: Probability Value

The relationships among the variables are depicted in Table 4. PTALL ↔ TSD: A strong, positive relationship was observed (β = 0.791, P = 0.001). This indicates that pedagogies in technology-assisted language learning significantly enhance teacher-student dynamics. TSD ↔ PLO: A very strong, positive relationship was found (β = 0.853, P = 0.001). This demonstrates that strong teacher-student dynamics significantly contribute to positive perceptions of learning outcomes. PLO ↔ PTALL: A strong, positive relationship was also observed (β = 0.784, P = 0.002). This suggests that positive perceptions of learning outcomes significantly align with the use of technology-assisted pedagogies. All relationships were statistically significant at the $P < 0.05$ level, as indicated by the low probability values (P = 0.001 and P = 0.002). The standard errors for the relationships ranged from 0.125 to 0.345, indicating reasonably precise estimates for all relationships. The results highlight significant and strong positive relationships among pedagogies in technology-assisted language learning, teacher-student dynamics, and perceptions of learning outcomes. These findings emphasize the interconnected nature of these variables, suggesting that well-designed pedagogical approaches and strong teacher-student dynamics contribute to improved perceptions of learning outcomes in educational contexts.

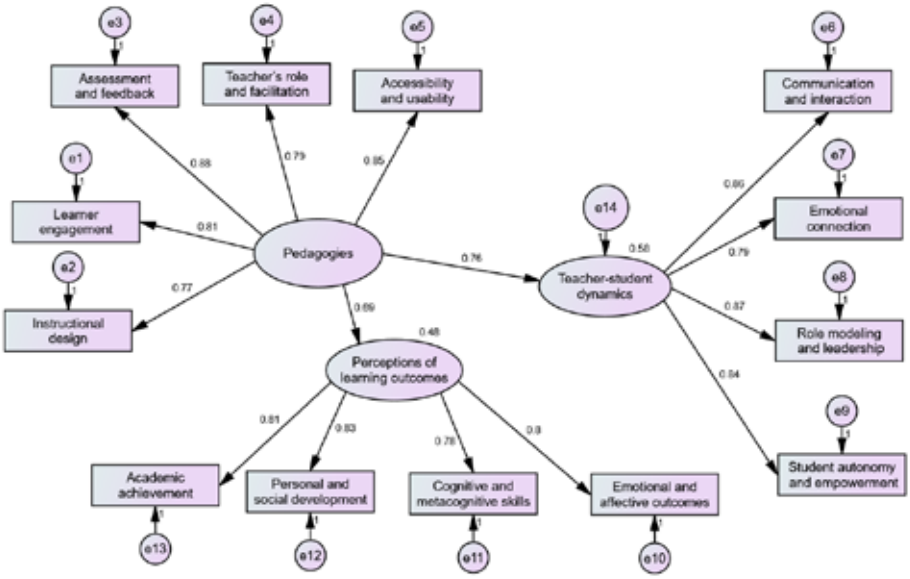

Figure 2. *The final measurement model*

Figure 2 depicts that pedagogies significantly influence Teacher-student dynamics (β = 0.76) and Perceptions of learning outcomes (β = 0.69), directly. Teacher-student dynamics moderately influence perceptions of learning outcomes (β = 0.48), indirectly. Teacher-student dynamics act as a mediator, strengthening the indirect impact of pedagogies on learning outcomes. All constructs are supported by high factor loadings (≥0.77), indicating strong construct validity.

Table 5. *Structural model assessment*

PARAMETER	ESTIMATE	LOWER	UPPER	P
TSD	.583	.165	.349	.001
PLO	.692	.249	.499	.001

The structural model assessment in Table 5 evaluated the effects of the variables. TSD: The parameter estimate for teacher-student dynamics was 0.583 (95% CI: 0.165–0.349, P = 0.001), indicating a significant positive contribution of teacher-student dynamics to the structural model. PLO: The parameter estimate for perceptions of learning outcomes was 0.692 (95% CI: 0.249–0.499, P = 0.001), demonstrating a significant and strong positive effect on the structural model. Both parameters were statistically significant (P = 0.001), suggesting that the effects are unlikely to have occurred by chance. The confidence intervals for both estimates are relatively narrow, indicating reliable and precise estimates. PLO (0.692) has a stronger effect on the structural model compared to TSD (0.583). These results suggest that perceptions of learning outcomes play a more dominant role in influencing the dependent variable compared to teacher-student dynamics. The findings from the structural model assessment highlight the critical roles of teacher-student dynamics and perceptions of learning outcomes in the model. Both variables exhibit statistically significant and positive effects, with perceptions of learning outcomes showing a stronger influence. These results underscore the importance of fostering positive teacher-student dynamics and enhancing perceptions of learning outcomes to improve the overall effectiveness of the educational framework. In other words, approximately 58% of the variations observed in students' TSD can be attributed to the influence of their Pedagogies in Technology-Assisted Language Learning (PTALL). This finding highlights the significant role that effective pedagogical strategies in technology-enhanced language learning environments play in shaping the quality of teacher-student interactions. Strong PTALL practices, such as providing accessible and engaging instructional materials, offering timely feedback, and fostering collaborative activities, likely contribute to a more dynamic and positive teacher-student relationship. Furthermore, approximately 69% of the variations observed in students' Perceptions of Learning Outcomes (PLO) can be attributed to the influence of PTALL. This underscores the critical impact of PTALL on students' views of their academic achievements, personal and social development, cognitive and metacognitive skills, and emotional and affective outcomes. When PTALL strategies are implemented effectively, they not only enhance the learning experience but also strengthen students' confidence in achieving meaningful and long-term educational outcomes. These findings suggest that prioritizing robust and innovative PTALL practices is essential for fostering both the interpersonal and academic dimensions of the learning process.

5. Discussion

The findings on how teachers and students perceive the role of technology in learning align with Cognitive Appraisal Theory (CAT), which posits that emotional responses to an event are shaped by individuals' appraisals (or evaluations) of the situation. In the context of TALL, teachers' and students' positive or negative appraisals of the technology used in

the classroom can influence their emotional engagement and the effectiveness of the learning process. If teachers and students perceive the use of advanced technologies (e.g., interactive platforms, AI-based tools) as beneficial for enhancing learning outcomes and streamlining communication, their emotional responses will likely be positive, leading to greater engagement and better learning outcomes. Conversely, if they view technology as an overwhelming challenge, this negative appraisal could lead to stress, frustration, and lower satisfaction with the learning process. Emotional Intelligence (EI) refers to the ability to recognize, understand, and manage emotions in oneself and others. The results showing that teachers with higher emotional intelligence were more adaptable to TALL practices are consistent with EI theory. Teachers who possess high emotional intelligence can better manage their emotional responses to new technology, which in turn allows them to better engage with students and adapt their teaching strategies. This adaptability fosters positive teacher-student dynamics, enhancing the overall learning experience. For example, teachers with high EI can empathize with students' frustrations regarding new technology and offer effective support, resulting in a more positive emotional climate and better learning outcomes. According to Social Constructivism, learning is a socially constructed process that occurs through interactions with others and the environment. The results that TALL promotes collaboration between students and teachers and facilitates peer interactions through digital platforms align with this theory. The findings suggest that TALL tools—such as discussion boards, virtual classrooms, and collaborative platforms—create opportunities for students to engage in shared problem-solving, which is central to Social Constructivism. These tools help students build knowledge collectively, leading to deeper learning outcomes. The teacher's role as a facilitator of these interactions supports the constructivist idea that learning is best achieved in a collaborative and interactive environment. Self-Determination Theory (SDT) emphasizes the role of autonomy, competence, and relatedness in fostering intrinsic motivation. The results showing that students who have more control over their learning processes and can choose from a variety of technological tools felt more motivated are linked to SDT. Students who have the autonomy to use technology to personalize their learning (e.g., through adaptive learning platforms or online courses) experience a sense of competence and achievement, increasing intrinsic motivation. Moreover, TALL facilitates relatedness by enabling students to interact with peers and instructors in dynamic ways, thus fulfilling the key needs outlined by SDT and contributing to positive emotional responses and elevated learning outcomes.

The results suggest a robust and statistically significant positive relationship between PTALL and TSD, with a standardized regression coefficient (β) of 0.791 and a p-value of 0.001. This indicates that as PTALL increases, TSD also improves, highlighting the important role that technology-assisted pedagogical methods play in enhancing teacher-student interactions. This finding aligns with well-established theoretical frameworks such as constructivist theory and social learning theory, which emphasize the importance of active and engaging learning environments in fostering meaningful interpersonal relationships between teachers and students. According to constructivism, learning occurs most effectively when students actively participate in their educational experiences, and when teachers facilitate an environment where knowledge is co-constructed through collaboration and engagement. In this context, PTALL can be seen as creating such an environment, where both the teacher and student actively engage with each other through technology.

Similarly, social learning theory supports the idea that interactions within a social context—such as the teacher-student dynamic—are crucial for learning. According to this theory, learners benefit from observing and interacting with others in a social context, and these interactions contribute to the development of knowledge and skills. The positive relationship between PTALL and TSD suggests that the use of technology in teaching encourages more dynamic, reciprocal communication between teachers and students, which is essential for enhancing the learning experience. In practical terms, this result implies that adopting technology-assisted pedagogies can significantly improve the quality of teacher-student interactions, making them more engaging, responsive, and collaborative. This, in turn, could lead to more effective learning outcomes as students feel more connected and supported in the learning process. Additionally, the strong statistical significance ($P = 0.001$) reinforces the robustness of the relationship, indicating that the observed effect is highly unlikely to be due to chance. This provides strong empirical support for the claim that PTALL is a key factor in enhancing teacher-student dynamics, and suggests that educational institutions could benefit from further integrating technology into pedagogical practices to foster stronger, more effective teacher-student interactions.

The results highlight the significant predictive power of PTALL on both TSD and PLO, offering valuable insights into how well-structured pedagogical approaches influence educational outcomes. Firstly, the finding that 58% of the variation in TSD can be explained by PTALL underscores the critical role that effective technological pedagogies play in shaping positive teacher-student dynamics. This suggests that when technology is integrated thoughtfully into teaching methods, it can foster stronger, more collaborative, and engaging interactions between teachers and students. The relatively high explanatory power indicates that PTALL is a major factor in enhancing how teachers and students communicate and work together, reinforcing the notion that technology can facilitate better connections in the classroom. This aligns with previous research that highlights the role of interactive, technology-driven teaching strategies in promoting a positive and supportive learning environment. More compelling is the finding that PTALL explains 69% of the variation in PLO, which is a substantial predictive effect. This indicates that the implementation of effective technology-assisted pedagogical approaches not only improves teacher-student dynamics but also has a profound impact on students' perceptions of their learning outcomes. The strong relationship between PTALL and PLO suggests that when technology is used to enhance pedagogical practices, students are more likely to feel satisfied with their academic achievements and their overall learning experience. This is particularly important because students' perceptions of learning outcomes play a crucial role in their motivation and engagement, potentially influencing their future academic performance and interest in the subject matter.

These findings collectively suggest that the use of technology in teaching does more than just facilitate communication—it actively contributes to improved educational outcomes. The fact that PTALL has such a strong influence on both teacher-student interactions and students' perceptions of their learning achievements suggests that the integration of technology can be a powerful tool for creating a more engaging, effective, and rewarding learning environment. The substantial predictive effects (58% for TSD and 69% for PLO) also imply that institutions and educators should consider prioritizing the development and implementation of well-structured technology-assisted pedagogies. By doing so, they can foster not

only better interpersonal relationships in the classroom but also improve students' academic experiences and perceptions, ultimately leading to enhanced learning outcomes.

By anchoring the findings in established educational theories, the study reinforces the relevance of constructivist and social learning approaches in contemporary language education. This integration provides a theoretical basis for future research and practice in TALL. The strong positive relationships between PTALL and TSD, as well as between TSD and PLO, highlight the critical need for educators to prioritize innovative and engaging technological pedagogies. By cultivating environments where students feel supported and engaged, educators can enhance both interpersonal dynamics and learning perceptions. The findings can inform instructional design by suggesting that robust PTALL strategies—such as interactive activities, timely feedback, and accessible materials—are instrumental in shaping positive educational outcomes. Developers of language curricula can utilize these insights to create or refine programs that effectively leverage technology. By demonstrating that positive perceptions of learning outcomes have a considerable effect on the educational framework, the results suggest that fostering student confidence and satisfaction is vital for enhancing educational effectiveness. This empowerment not only influences academic achievement but also students' emotional and social development.

In comparing these results with previous studies, several key themes and patterns emerge. The current study's findings indicate strong positive relationships among PTALL, TSD, and PLO, with the statistical significance of these relationships bolstering the evidence for their interconnectedness. This aligns with previous studies, such as those by Outlaw and Grifenhagen (2024), which found that blended learning environments enhance teacher-student interactions and lead to improved student satisfaction with learning outcomes. Additionally, Davies et al. (2024) emphasized the role of teacher and peer support in fostering knowledge creation through technology-enhanced collaborative learning. These findings underscore the importance of digital pedagogies in shaping student experiences and perceptions of learning, reinforcing the idea that technology-mediated instruction plays a central role in modern education.

The current study further quantifies these relationships, providing specific beta coefficients that illustrate the strength of these connections. Prior research has consistently highlighted that effective technology use fosters better teacher-student dynamics. Wu et al. (2024) noted that MALL significantly increased student engagement and communication with instructors, while Pan and Wang (2025) explored how AI literacy among teachers can empower digitalized teaching approaches. The present study adds depth to these findings by quantifying the extent to which PTALL predicts TSD, reinforcing the concept that technological pedagogies enhance interpersonal dynamics in educational settings. Furthermore, Qi and Derakhshan (2024) examined technology-based collaborative learning and found that social regulation significantly influenced academic emotions and performance. These studies collectively suggest that integrating advanced technology into pedagogy not only strengthens teacher-student relationships but also enhances students' self-efficacy and motivation to learn.

The current study's finding that PLO is heavily influenced by PTALL supports prior research by Tang et al. (2024), which showed that specific technological pedagogies positively impact students' views on their learning achievements. The stronger parameter estimate for PLO (0.692) in the current study underscores the critical role of students' perceptions in evaluating educational effectiveness. This suggests that while both TSD and PTALL

contribute to learning outcomes, the way students perceive their own achievements may be even more impactful. Similarly, Derakhshan and Yin (2024) highlighted the role of positive emotions, such as hope and pride, in predicting academic engagement, indicating that student perceptions and emotions are integral to educational success. Moreover, Wang et al. (2025) explored the role of classroom climate, AI literacy, and resilience in fostering student engagement in AI-assisted EFL classrooms, further validating the assertion that technology-infused pedagogies play a crucial role in shaping students' academic experiences. These findings collectively reinforce the importance of fostering positive perceptions of learning outcomes through well-designed, technology-enhanced instructional approaches.

The current study reports that approximately 69% of the variations in students' perceptions of learning outcomes can be attributed to PTALL. This is in line with insights from Renuga Devi et al. (2024), who emphasized that effective technology integration correlates with improved emotional and cognitive outcomes for students. However, the current study provides a more precise statistical basis for these expected variations, thereby contributing to the robustness of the conclusions regarding the predictive power of pedagogies in TALL. Many earlier studies relied on qualitative assessments or less rigorous statistical techniques, which sometimes limited their ability to draw firm causal interpretations. The current study's reliance on structural equation modeling (SEM) enhances the validity of its findings, offering a comprehensive analysis of the relationships among the variables. This methodological strength improves the reliability of the conclusions drawn, addressing criticisms faced by earlier research designs. Overall, while previous studies have established foundational relationships among TALL, TSD, and PLO, the current findings provide a more nuanced understanding that quantifies these relationships and highlights areas for improvement in educational practice. The emphasis on robust PTALL practices as predictors of both TSD and PLO is a significant contribution to the field, suggesting actionable steps for educators to enhance the effectiveness of technology in language learning.

6. Conclusion

The current study emphasizes the strong and positive interrelationships between PTALL, TSD, and PLO, highlighting the central role of technology in modern education. The findings clearly illustrate how effective integration of technology into language teaching methods can lead to improved interactions between teachers and students, as well as enhanced student perceptions of their learning experiences. By fostering more engaging and interactive learning environments, PTALL not only supports more dynamic and collaborative teacher-student relationships but also contributes to greater learner satisfaction and motivation. In the context of EFL, where technology has become increasingly prevalent, the study's results suggest that when technology is used strategically, it can bridge gaps in communication, personalize learning experiences, and promote active participation. This aligns with the growing body of research supporting the role of digital tools in creating more student-centered, interactive, and engaging classroom environments. Furthermore, the strong relationship between PTALL and TSD indicates that technology can help foster a more supportive and responsive teaching atmosphere, where students feel more connected to their teachers and peers. Additionally, the positive impact of PTALL on perceptions of learning outcomes suggests that learners'

satisfaction with their academic progress is significantly influenced by how technology is embedded into the teaching process. When students perceive the use of technology as enhancing their learning experience, it can increase their confidence and satisfaction with their educational achievements. This, in turn, leads to higher levels of motivation and greater overall success in language learning. The results emphasize the importance of incorporating effective technology-based pedagogical practices into EFL classrooms to improve not only teacher-student interactions but also students' perceptions of their learning outcomes.

The study reinforces existing educational theories, such as constructivism and social learning theory, by demonstrating how interactive and engaging pedagogical approaches facilitated by technology can improve teacher-student relationships and influence students' perceptions of their learning outcomes. This adds depth to the literature on TALL, providing empirical support for the interconnectedness of these variables. From a practical perspective, the findings suggest that educators should prioritize the adoption of innovative and robust PTALL strategies to foster positive teacher-student dynamics and, subsequently, enhance student perceptions of their learning experiences. By training educators in effective technology integration and encouraging collaborative learning environments, institutions can improve overall language learning outcomes.

Here are some potential limitations and future suggestions for the study. The study may focus on a specific population, region, or type of technology, limiting the ability to generalize the findings to broader contexts or different educational settings. Variations in technological infrastructure, cultural contexts, and student needs could impact how TALL affects learning outcomes. The study might not account for disparities in access to technology. Students or teachers in resource-limited environments may experience different outcomes compared to those with access to advanced technological tools, potentially skewing the results and limiting the applicability of findings across diverse educational systems. The study may overlook the role of teacher training in the successful implementation of TALL. Teachers' technological literacy and their ability to adapt to new tools may significantly affect the outcomes, but this factor may not be sufficiently explored in the study. Teacher-student dynamics in technology-assisted learning are complex and may be influenced by numerous factors, including classroom culture, teaching style, student engagement, and external support systems. These variables might not be adequately addressed, leaving out key elements that affect the findings. A small or homogeneous sample might limit the study's ability to capture a diverse range of experiences with TALL. It may fail to represent different types of learners (e.g., varying proficiency levels, backgrounds, or learning preferences), which could affect the study's robustness and relevance. The study may place too much focus on the technological aspect while neglecting other critical factors, such as curriculum design, teacher-student rapport, and pedagogical strategies. Technology is a tool, but its effectiveness is often contingent upon how it is integrated into the broader educational framework. These limitations highlight areas that could influence the conclusions of the study and suggest areas for further research to enhance understanding of the role of technology in language education. Future research should explore the long-term effects of TALL on language acquisition and retention to assess sustainability beyond immediate learning outcomes. Additionally, studies could investigate the impact of different demographic variables (e.g., age, learning preferences, socio-economic background) on the relationships among PTALL, TSD, and PLO. Another

area of interest could be the exploration of specific technologies and their varying influences on these dynamics to identify best practices in TALL implementation. Finally, qualitative research could provide deeper insights into student and teacher experiences, enriching our understanding of the nuances in teacher-student interactions within technology-enhanced learning environments.

7. References

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