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REVIEW

Activity Theory in Education Research on the Use of Digital Tools in Language Teaching and Learning

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ABSTRACT

While Activity Theory (AT) has been made prevalent in language education research, there is still no systematic review to specify how such a theory can offer insights into the dynamic relationships between learners, educators, digital tools, and socio-cultural contexts. This paper reviews studies published between 2020 and 2025, adopting the principles of systematic review comprising search strategy, inclusion criteria, data extraction, quality assessment, thematic analysis, and narrative report. The results from thirty-five empirical studies on the use of AT in language education reveal seven dominant themes: (1) Teacher-student interactions and tool-mediated learning; (2) Mediation of digital tools in language learning, or how tools facilitate learning while posing challenges related to accessibility and engagement; (3) Identity construction for teachers and learners via digital tools; (4) Collaborative learning and peer feedback fostered by digital platforms; (5) Blended and online learning environments; (6) Tool-mediated learning processes, in which learning outcomes are shaped by both traditional and digital tools; and (7) Contradictions and tensions in digital learning, indicating conflicts between tools, rules, and community lead to transformative learning opportunities. Additionally,

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emerging themes have suggested an increasing focus on AI integration as a mediating tool and the shift towards placing subjects—learners—as central agents within self-directed, social-oriented learning environment. This review not only underscores AT's adaptability in addressing complex, technology-mediated educational processes across contexts and reinforces the relevance of AT in understanding digital tool integration but also points to future research directions, including AT's potential to shape educational policies and curriculum development.

Keywords: Activity Theory; Digital Tools; Educational Research; Teaching and Learning English

1. Introduction

AT has its roots in the cultural-historical psychology of Lev Vygotsky [1], who was later supplemented by Alexei Leontiev [2] to offer an all-encompassing perspective on human activity and learning [3–5]. Vygotsky's sociocultural theory stressed that cognitive development occurs through mediated processes in which actions or interactions are shaped, supported, or influenced by tools, symbols, or other intermediaries that facilitate understanding and activity. On this basis, Leontiev proposed the concept of activity systems, which makes a distinction between individual actions and the greater collective activities organized around common objectives. As framed by Engeström [3] and Kaptelinin and Nardi [4], AT posits that human activity is shaped by the tools utilized, the rules that govern the activity, the community within which the participants are located, and the division of labour among the members.

In the context of language teaching, AT has proven to be more useful in comprehending the nuanced processes of learning in practical contexts. It offers a comprehensive lens through which to analyze the intricate and changing interplay between students, teachers, digital technologies, and the surrounding social-cultural context [6]. Besides, the framework allows researchers to examine the mediation of language learning by digital tools, including software, applications, or online platforms, their impact on learner-educator interaction, and the reciprocal shaping by contextual socio-cultural factors [7,8]. In view of the growing use of digital instruments and collaborative work in language teaching and learning, AT has emerged as an important lens through which to make sense of these changes. This review attempts to illustrate the ways AT has been utilized in recent studies (2020–2025) on language education with a particular emphasis on the use of digital and AI tools. The paper aims to reveal critical gaps to inform subsequent applications of AT in language education research, focusing on the use of digital tools.

2. Background

AT enhances understanding of human activity as inherently socially and culturally mediated from a Vygotskian perspective [9–12]. Vygotsky's system focused on the relationship among the subject (the individual(s) involved), the object (the goal of an activity), and the tools or signs that mediate it. This concept served as a basis for further developments by Engeström [2,13], who, in his third-generation model, framed human activity as systemic, collective, and dynamic. In this model, there are six interconnected elements: the subject, the tools or mediating artifacts which include language and digital technologies, the object, the rules which are explicit or implicit normative frameworks guiding the activity, the community which encapsulates the social context of the activity, and the division of labour which deals with the distribution of roles and responsibilities. These elements constantly interact and, in the process, generate through diverse forms and metamorphic outcomes or transformative changes in a person's skills, understanding, or identity that result from significant learning or developmental experiences [14,15].

AT is especially effective for the study of intricate learning environments that utilize advanced technologies [6]. Educational researchers can study interactions on the individual, institutional, and systemic levels because of the multi-layered nature of educational activity. Such a broad analytical scope reveals not only synergies but also structural tensions or contradictions within activity systems [10,12,16]. Instead of being problematized as barriers, these contradictions are viewed as pathways for learning, adaptation, and innovation. In this manner, AT offers a flexible framework for investigating the evolution of educational practices in relation to mediating tools, cultural expecta-

tions, and institutional structures.

Within the realm of language teaching and learning, AT has emerged as a useful framework to understand the relationships among the learners, instructors, technologies used, and the socio-cultural context. Its application ranges across various domains like reading comprehension [16,17], academic writing [9,14,15,18–21], and instructional methods incorporating technology such as task-based and blended learning [16,22]. It has also been used to study peer review [11,15,18,21,23], teacher professional development [19,24], and student motivation [25,26].

Moreover, there is an active line of research that investigates the mediating role of technology in the language learning process. Mobile-assisted learning [12,17], online peer feedback systems [18], automated writing evaluation systems [9], and intelligent tutoring systems [12,27] have all received scholarly attention. The above-mentioned technologies stimulate language learning while simultaneously transforming the learners' and teachers' roles, redefining classroom dynamics, and bringing to light pedagogical contradictions within activity systems. There is also ongoing research focusing on AI-driven technologies like natural language generation [28] and automated corrective feedback [20] as primary mediating artifacts. These developments transform not only the outcomes of education but also the dynamics of the classroom, the role of the educator, and the nature of feedback in language teaching.

The scope of this review focuses on the research conducted between 2020 and 2025 regarding technology's role in language education, using AT as the central framework to guide the synthesis of findings. More specifically, the review focuses on how AT has been applied in research on digital tools in language education, rather than on AT in language education more broadly. Besides, the scope targets studies using digital tools for language learning within the framework of AT because digital tools present unique affordances, challenges, and forms of mediation that differ from non-digital tools. Limiting the scope to this context allows for a clearer understanding of how AT is applied to analyze technology-mediated language learning in an era of rapid educational digitalization. By plotting results on the components of Engeström's activity system, the review illustrates how digital mediation aids or impedes language learning, providing a holistic perspective. In this way, the review seeks to enrich pedagogical approaches and inform subsequent research by revealing the socio-culturally embedded educational contexts and the digital tool contradictions and affordances.

Research questions:

1. In studies published between 2020 and 2025, how has AT been applied to investigate the use of digital tools in language education across different geographical and cultural contexts?
2. What key themes of AT emerge from these studies?

3. Method

This systematic review strived to capture AT's implementations in language education research from 2020 to 2025, paying specific attention to the role of technology in language learning. In particular, this literature review makes use of theory-driven systematic approaches to collate literature examining the use of AT in language education with technological tools. The procedure followed the guidelines of PRISMA 2020 [29], which represents the most recent update to the preferred reporting items for systematic reviews and meta-analyses, integrating current best practices for ensuring transparency, completeness, and reproducibility in systematic reviews. Its structured checklist and flow diagram provided a clear framework for documenting the search, screening, eligibility, and inclusion processes, aligning well with the study's aim to synthesize evidence in a transparent and replicable manner. Below is the flow diagram:

In line with the PRISMA 2020 guidelines, the database search initially identified 90 records. After removing 18 duplicates, 72 records remained for title and abstract screening. Of these, 62 records were excluded for not meeting the inclusion criteria. Following full-text screening, 24 articles were excluded due to reasons such as a lack of empirical data, the absence of AT as a framework, or not focusing on digital tools in language education. Finally, 35 studies met all inclusion criteria and were included in the qualitative synthesis. This process is detailed in the PRISMA 2020 flow diagram (**Figure 1**), which is now included in the manuscript to provide an overview of the study identification, screening, eligibility, and inclusion stages.

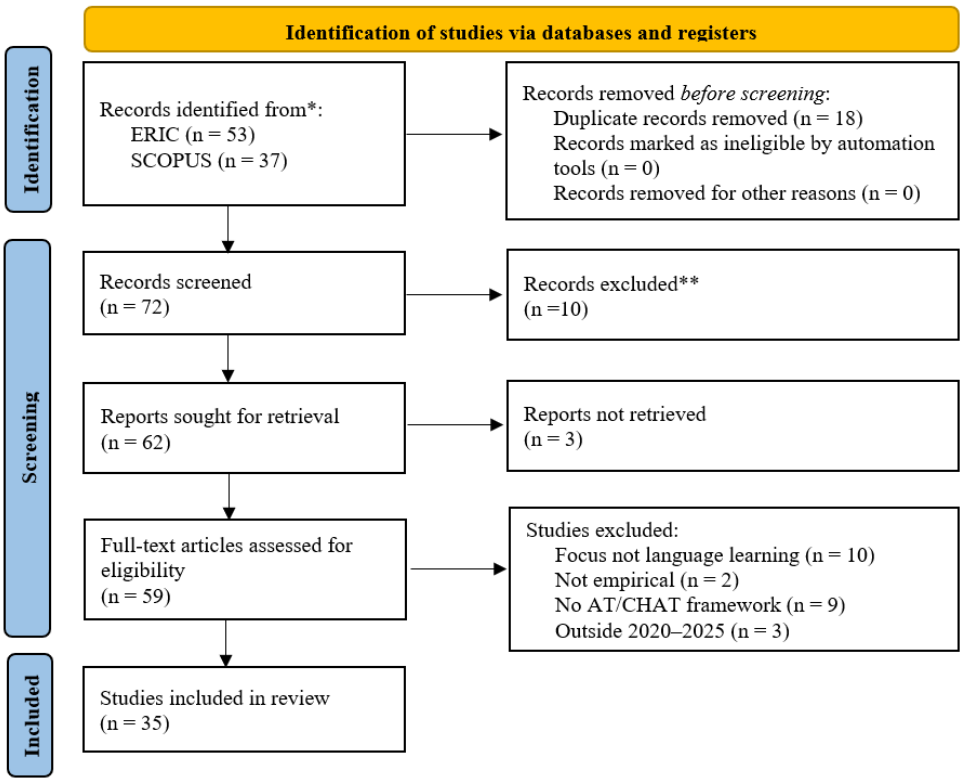

Figure 1. The PRISMA Flow Chart for the selection procedure.

Besides, each step in the review process was guided by established criteria: the retrieval strategy was based on Tranfield et al. [30]; inclusion criteria were set by Petticrew and Roberts [31]; extraction of data followed Booth et al. [32]; assessment of study quality was conducted following Higgins and Green [33]; thematic analysis was conducted according to Braun and Clarke [34]; and synthesis of findings was performed narratively as outlined by Popay et al. [35].

3.1. Search Strategy and Sources

Relevant studies were identified using comprehensive searches across major academic databases, including ERIC and Scopus. These databases were selected because of their extensive coverage in education, psychology, and applied linguistics peer-reviewed literature [36]. These databases were chosen for their comprehensive coverage in education, psychology, and applied linguistics literature [37]. The searches for the two databases are as follows:

ERIC (SU “Activity Theory” OR TI(“activity theory” OR “cultural-historical activity theory” OR CHAT) OR AB(“activity theory” OR “cultural-historical activity theory” OR CHAT)) AND (SU “Second Language Learning” OR SU “English (Second Language)” OR TI(“language education” OR “language learning” OR EFL OR ESL OR “second language” OR “foreign language”) OR AB(“language education” OR “language learning” OR EFL OR ESL OR “second language” OR “foreign language”)) AND (SU “Educational Technology” OR TI(“educational technolog*” OR digital OR mobile OR AI OR chatbot* OR MALL) OR AB(“educational technolog*” OR digital OR mobile OR AI OR chatbot* OR MALL)) Limits: Peer-reviewed; English; 2020–2025.

Scopus (“activity theory” OR “cultural-historical activity theory” OR “cultural historical activity theory” OR “CHAT”) AND (“language education” OR “language learning” OR “second language” OR “foreign language” OR EFL OR ESL) AND (“technology” OR “educational technology” OR “digital” OR “mobile” OR “AI” OR “chatbot*” OR “MALL” OR “language learning technolog*”) AND (PUBYEAR > 2019 AND PUBYEAR < 2026) AND (LIMIT-TO(DOCTYPE, “ar”) OR LIMIT-TO(DOCTYPE, “re”)) AND (LIMIT-TO(LANGUAGE, “English”))

(Notes: EFL: English as a Foreign Language, ESL:

English as a Second Language, MALL: mobile-assisted language learning)

3.2. Inclusion and Exclusion Criteria

In order to ensure the selected studies had a focused scope, a set of inclusion and exclusion criteria was established. The inclusion criteria stipulated that the relevant studies pertained to language teaching in the context of EFL or ESL courses; were published in peer-reviewed journals to meet academic standards [37]; consisted of empirical research, systematic reviews, or meta-analyses that provided valuable insights based on evidence; made explicit use of AT as a theoretical or analytic framework; were released between the years 2020 and 2025 and were written in English.

On the other hand, the exclusion criteria eliminated non-peer-reviewed documents such as opinion articles, editorials, and blog posts; theoretical documents lacking empirical support; research conducted in unrelated fields such as corporate training or healthcare; and publications not written in English. This stringent screening guaranteed that the studies included in the review were methodologically robust and aligned with the research questions.

3.3. Study Selection Process

The selection process adhered to a defined step-by-step screening method. The first step involved screening all the studies to focus on their titles and abstracts to remove those that would not adhere to the inclusion criteria [31]. This step helped refine the review by early removing some irrelevant and certainly lower-quality entries. In the second stage, the complete texts of the remaining studies were analyzed in detail by two separate reviewers. Every study was analyzed for its theoretical framework relative to AT, its research design, and its applicability in the context of language teaching. In situations where there were differing opinions about whether a study should be included or excluded, the reviewers resolved disagreements through discussion, or, when necessary, by appealing to a third reviewer [38]. This systematic team effort made it possible to maintain consistency and reliability throughout the selection process.

3.4. Quality Assessment

Each study was assessed for having a coherent research strategy and well-defined theoretical rationale based on AT, including all necessary data collection and analysis steps. For quantitative studies, we examined potential sources of bias, including selection bias, small sample sizes, and other confounding factors, as part of the overall quality appraisal; no formal standardized risk of bias assessment tool was applied. Only those studies that met a minimum threshold for sound methodology and conceptual relevance were included in the final synthesis, which strengthened the credibility and reliability of the review's findings [37].

3.5. Data Extraction

Adhering to a systematic method, data extraction for the selected studies was conducted using a predetermined data extraction template to maintain uniformity throughout the studies [32]. The most critical information from each study included study type (e.g., qualitative, quantitative, and or mixed-methods); study setting (e.g., classroom, other learning environments, fully online); subjects/participants (learners and teachers); main findings and results in relation to the use of AT, digital mediation, collaboration, feedback, and evaluation; and final remarks and recommendations regarding educational practice and research directions. This approach allowed for accurate extraction and meaningful synthesis of all relevant data. As presented in **Figure 1**, 35 papers were used for the analysis out of the 59 screened ones, excluding 10 articles focusing not on language learning, two non-empirical studies, nine not using AT, and three outside 2020–2025.

To enhance the credibility of the thematic analysis, agreement among coders was secured by a systematic sequence of independent coding, iterative comparison of results, and collaborative reconciliation of discrepancies. Using the primary codebook, two independent coders examined 20% of the documents. Inter-coder reliability, assessed through Cohen's Kappa, yielded $\kappa = 0.78$, indicating substantial agreement [39]. Any differences were discussed and resolved, and the updated codebook was applied to the rest of the data. Additionally, theme validation was carried out through peer-checking to review the thematic interpretations for accuracy.

3.6. Data Synthesis

To separate findings, a thematic and narrative technique was applied together due to the breadth of the research. In accordance with Braun and Clarke's [34] guidelines, thematic analysis was used to recognize and sort important recurring patterns within qualitative and mixed-method studies. At the same time, a narrative synthesis was done to structure and explain the outcomes of quantitative studies so that they could be compared across different methodologies and expose some trends of evidence [36].

4. Results

The review of 35 papers based on the principles of systematic review discloses the following findings.

4.1. Geographical Distribution and Contexts of the Studies Using AT as the Theoretical Framework

The research gathered for this paper is from different parts of the world, such as Asia, the Middle East, Africa, Europe, North America, and Oceania, which further shows that AT has been used for decades to investigate the role of technology in language learning.

A significant portion of this research is concentrated in Asian contexts, including China [40–43], Taiwan [9,17], South Korea [44], Hong Kong [28] and Vietnam [45]. While this reflects the region's strong engagement with digitally enhanced English language teaching in rapidly evolving educational markets, it also raises concerns about the global representativeness of the literature. In the Middle East, studies from Saudi Arabia [46] and Qatar [47] reveal how local cultural and institutional frameworks shape technology adoption, often exposing tensions between global pedagogical models and regional norms. Iranian work, such as Hajimaghsoodi and Maftoon [14] and Nazari and Karimpour [48], foregrounds emotional labor, identity, and computer-mediated communication (CMC) use, drawing attention to socio-affective dimensions often overlooked in technology-driven studies.

Asian research, particularly in China and Vietnam, focuses on secondary and tertiary education, emphasizing mobile-assisted learning, AI integration, and learning management system (LMS) use, approaches that highlight innovation but sometimes under-engage with deeper pedagogical critique. By contrast, high-income contexts such as South Korea, Canada, and the U.S. prioritize adult and higher education, stressing collaboration, digital feedback, and identity negotiation, often assuming resource-rich settings. Middle Eastern and African studies expose disparities in technological access and infrastructure, revealing contradictions such as gaps between policy and practice and mismatched resources for assistive technologies. Overall, these varied contexts illustrate both the adaptability and the limits of Activity Theory in examining how local conditions shape the possibilities and constraints of educational technologies.

In addition, the application of AT in the 35 studies covers a range of educational levels from secondary school to higher education and even adult and online/blended education, as illustrated in **Figure 2**.

This scope shows the adaptability of AT in examining mediated language interactions, sociocultural contradictions, and language education frameworks. AT research has investigated digital technology's role in EFL across secondary and university contexts, including collaborative and multimodal tasks. For example, Yang and Kyun [12] studied the impacts of digital storytelling on learning objectives and the role of digital tools including software, applications, or online platforms in mediation. Related work spans AFL reading strategies [47], online writing and speaking tasks [9,19], feedback systems and intelligent tutoring [14,27], and automated evaluation systems for graduate L2 writing and learner autonomy [49,50].

Moreover, several articles examined AT as a lens to evaluate teachers' professional identity and emotional labor. For example, Alshakhi [46] analyzed participation and assessment in engagement in online Saudi university classrooms, while Li et al. [49] researched the emotional tensions of EFL teachers in Iranian private institutions. In the same vein, Kim and Kim [44] and Consoli and Dikilitaş [51] documented the learning pathways and enduring conflicts of teachers experiencing curriculum reform and action research engagements. These studies demonstrate the ways teachers negotiate the intersection of their professional work and institutional frameworks, along with digital technologies.

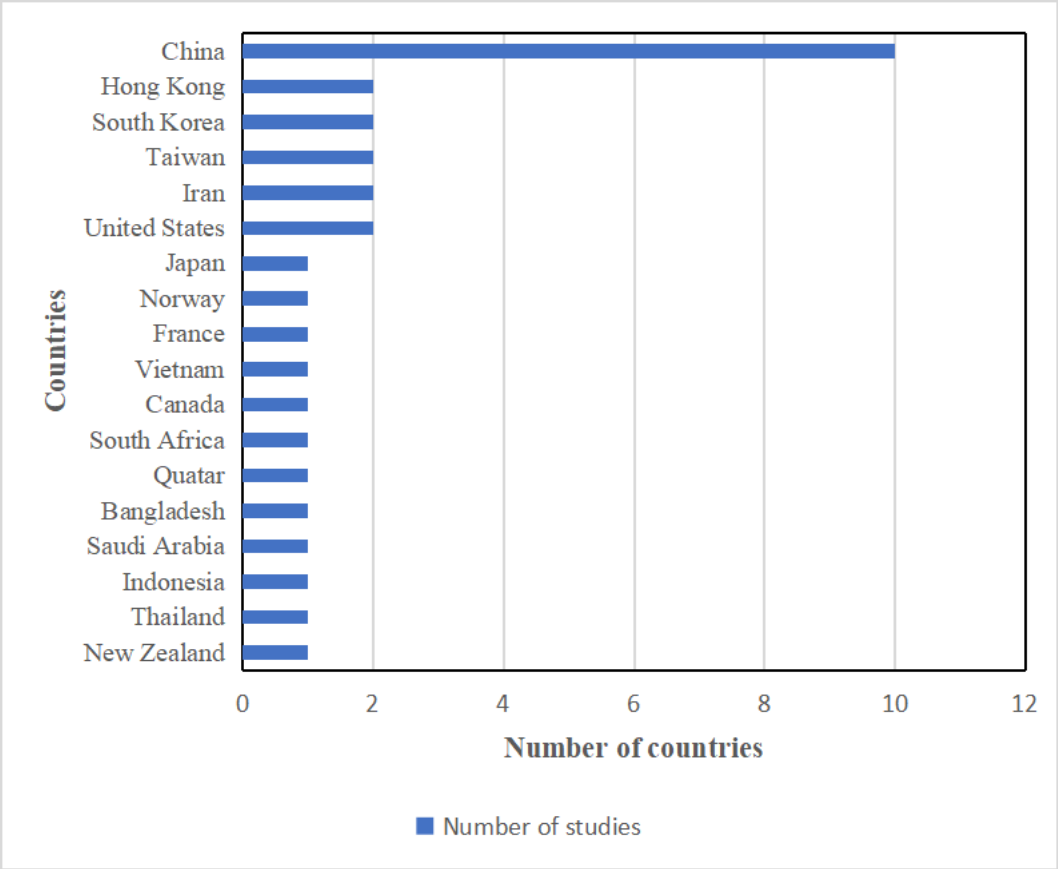

Figure 2. Numbers of reviewed studies by country (2020–2025).

There were also studies focusing on remote and blended learning, especially in relation to the recent pandemic. Li [22] conducted a meta-analysis on blended learning in China, while Rong and Yao [52] and Esnaashari et al. [53] studied the evolution of tool use, rule contradictions, and learner engagement within hybrid university courses. Alshakhi [46], however, focused on the fully online environments and how digital assessment affected student engagement and performance. These studies viewed primary and secondary contradictions or the internal tensions within one component and tensions between different components of the activity system as central mechanisms for advancing learning design, evolving through cyclical refinement of tools over time. Furthermore, an increasing number of researchers are applying AT to the study of learning environments that incorporate AI. For example, Guo et al. [43] studied the mediation of argumentative writing by AI chatbots in higher education. In the same fashion, Wu and Li [42] examined the robot-assisted language learning in EFL contexts, and Li et al. [54] conducted a comprehensive review on the educational outcomes with AI chatbots incorporating AT elements (subject, tools, rules, etc.). All of these examined the influence of AI tools as mediational artifacts or tools, symbols, or objects—physical or conceptual—that people use to support, shape, or enhance thinking, communication, and action within a cultural context, impacting learner autonomy, engagement, and feedback.

To conclude, the reviewed studies show that AT has been applied across varied geographical regions and educational contexts, from secondary to higher education, adult learning, and both blended and online settings. In these contexts, AT has been used to analyze how digital and AI-based tools mediate learning and how local cultural and institutional factors shape their integration. The findings reveal that contradictions arising from technological limits, institutional structures, or cultural expectations often act as catalysts for expansive learning and professional growth. Overall, AT proves to be a flexible framework for examining technology-mediated language education worldwide and for understanding how local contexts influence its possibilities and constraints.

4.2. The Use of AT in Recent Language Education Research

The reviewed research papers show that the application of AT is broad and complex, demonstrating the adequacy of this framework for educational systems and processes analysis. Below is a detailed analysis of how AT has been utilized across the papers, emphasizing the concepts of mediation, contradictions, sociocultural influences, and expansive learning or a process where learners collectively transform their activity system by creating new objects, tools, and ways of working.

Theme 1: Using AT to understand teacher-student interactions and tool-mediated learning

The AT framework has been utilized to study the extent to which language education tools impact the interactions between students and teachers. Recent research utilizing AT has examined the instructional and interactional aspects of teaching and learning in different contexts and settings of EFL and ESL education, as shown in **Table 1** below.

Table 1. Using AT to understand teacher-student interactions and tool-mediated learning.

Study	Context	Tool-Mediation	Interaction Focus
Ballantyne et al. (2021) [27]	Pre-service teachers' interactions with ITS tools	Intelligent Tutoring System (ITS)	Language support, error feedback
Chen et al. (2022) [9]	Collaborative writing in EFL classroom	Online shared writing platforms	Learner collaboration and teacher support
Esnaashari et al. (2025) [53]	Blended learning in higher education	Educational tools, LMS, digital interaction	Lecturer-student interaction and contradictions
Guo et al. (2024) [43]	EFL students' chatbot-assisted argumentative writing	AI chatbot tools	Teacher-student-chatbot writing process, feedback cycles, and support strategies
Nazari & Karimpour (2022) [48]	Computer-assisted language learning (CALL) for improving EFL learners' writing	Computer-Assisted Language Learning	Writing scaffolding
Li et al. (2022) [49]	Digital gaming and informal learning	Out-of-school digital games	Learner engagement with peers and environment
Li et al. (2025) [54]	Systematic review on AI chatbots	AI chatbot platforms	Student-chatbot-teacher dynamics, division of labor, scaffolding from teachers and bots
Min (2013) [19]	Multimodal speaking tasks via Padlet	Padlet	Student interaction and content co-construction
Wang & Khambari (2020) [55]	AR-supported English learning in vocational college	AR learning model, mobile tools	Teacher-student role shifts, collaboration
Woo et al. (2024) [28]	Digital multimodal composing	Digital authoring tools	Peer review and teacher guidance
Wu & Li (2024) [42]	Robot-assisted language learning in secondary/tertiary EFL classrooms	Robot tutors	Robot-learner-teacher mediation of speaking tasks and feedback
Yang & Kyun (2022) [12]	Digital storytelling in secondary EFL	AI tutors, feedback tools, intelligent agents	Learner-AI-teacher interaction and contradictions
Yuliani et al. (2022) [56]	Mobile learning in English language teaching at higher education	Smartphones	Student attitudes and readiness
Zhang & Zou (2022) [21]	Peer feedback for L2 writing	Online feedback platforms	Student strategies, peer collaboration, teacher roles
Zhang et al. (2024) [15]	Systematic review of technology-enhanced language learning (TELL) with NNR	Various digital tools	Student/teacher engagement issues

In South Africa, Ballantyne et al. [27] examined pre-service teachers' use of Intelligent Tutoring Systems (ITS), showing how adaptive feedback and self-directed learning functions are particularly valuable in resource-constrained settings, while also reshaping teacher–learner dynamics. Hajimaghsoodi and Maftoon [14] similarly found that CALL in EFL writing classes not only improved writing outcomes but also transformed traditional teacher roles. Studies on collaboration and feedback, such as Woo et al. [28] and Chen et al. [9], indicated that online platforms for peer review and multimodal composition promote active learner participation and enhanced instructor facilitation. Min [19] reported that Padlet supported Korean EFL learners' multimodal speaking and peer interaction, whereas Yang and Kyun [12] noted that AI-supported digital storytelling redefined relationships among students, teachers, and intelligent agents. Collectively, these studies suggest that digital tools extend beyond task mediation to reconfigure pedagogical relationships, agency, and interaction patterns.

Informal educational settings using digital technologies have been shown to enhance interaction with peers and educators. Li et al. [49] found that digital gaming promoted learner autonomy and engagement. In EFL writing, Li et al. [54] reported a shift from traditional instructor feedback to AI-assisted revision processes with ChatGPT, highlighting AI chatbots' roles as cognitive and social mediators in shared teacher–learner tasks. Guo et al. [43] examined chatbot-assisted writing, showing how teacher and chatbot jointly mediated feedback for argumentative writing, revealing tensions between algorithmic and human agents. Wu and Li [42] studied semi-autonomous robots as feedback monitors in oral language learning, while Zhang and Zou [21] and Wang and Khambari [55] explored peer review systems and augmented reality (AR) environments, noting their impact on learner–educator dynamics. Esnaashari et al. [53] compared student digital engagement with instructors' planned engagement in a blended university context, illustrating tensions affecting pedagogical mediation.

Collectively, these studies illustrate AT's capacity to dissect the complex interplay between digital tools, roles, and mediational processes in language classrooms. The reviewed studies suggest that effective integration of technology hinges not only on the capabilities of the tools themselves, but also on the systemic configurations of roles, rules, and interaction structures. Therefore, AT remains a pertinent framework for investigating the changes in the relations between teachers and learners in the context of language learning in a digitally enhanced environment.

Theme 2: The use of AT to shed light on the mediation of digital tools in language learning processes

AT is consistently applied in the context of language learning to examine how digital tools mediate the learning process. There is considerable diversity in the form and content of formal and informal educational settings, but AT has uniformly been employed to uncover how tools shape engagement, task execution, collaboration, and learner development.

In **Figure 3**, the one-way arrows depict mediation within AT, illustrating how components influence learning processes as an analytical abstraction rather than strict unidirectionality. Tools such as AI chatbots and shared platforms actively mediate interactions, as shown by arrows from "Digital tools" to "Teacher and student" and "Language learning tasks." The arrows also indicate the hierarchical organization of activity systems, where elements like tools and rules shape tasks, which in turn affect student engagement. While feedback loops exist, the diagram emphasizes directional influence to pinpoint where tensions arise, offering a clear visualization of mediation in technology-integrated language learning.

Blended learning and technology-enhanced instruction remain central in EFL research. In Chinese tertiary contexts, Li [22] and Li and Xu [40] showed how blended learning tools structure access to content and mediate cognitive, behavioral, and social engagement, while in New Zealand, Esnaashari et al. [53] revealed learning management system (LMS)-mediated gaps between pedagogical intentions and learner participation. Similar LMS-focused studies in vocational and curriculum settings [45,52] highlighted their role in shaping instructional design, and AR integration [55] redefined sentence construction and classroom roles. Mobile phones, as Yuliani et al. [56] found, fostered students' involvement and readiness in speaking lessons at higher education. AI-mediated environments have also gained traction, with Li et al. [54] linking chatbot use, including ChatGPT, to cognitive-emotional and agentic

development, and Yang and Kyun [12] assessing the promise and limits of intelligent tutoring and automatic writing evaluation (AWE) systems. Collectively, these studies show AI's capacity to reshape learner–object relations while cautioning against misalignments between tool functions and learner or societal expectations.

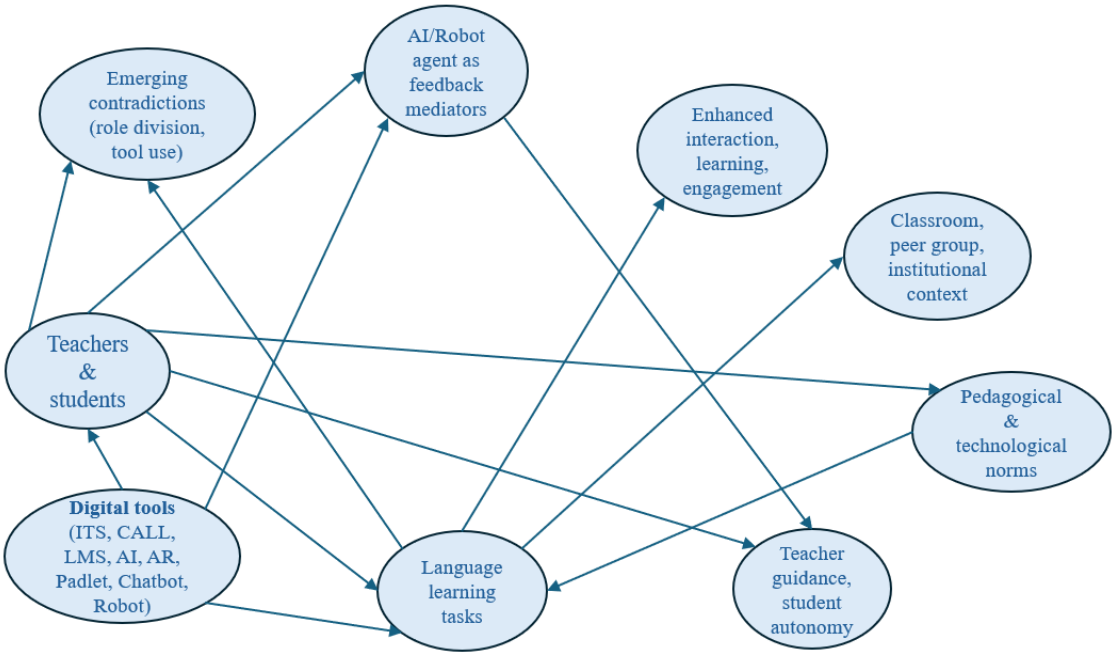

Figure 3. Conceptual map of teacher–student interaction and digital tool mediation within the AT framework.

Focusing on the role of AWE systems in mediating L2 revision strategies, writing and composition studies Chen et al. [9] followed with Lam [18] and Kessler [50] who provided web-based feedback and CALL tool usage through graduate and undergraduate level writing courses, showing how digital mediation restructured feedback incorporation and learner agency. Later, Min [19] and Woo et al. [28] showed the value of Padlet and digital authoring software as multimodal tools in learner interaction. Moreover, informal learning and out-of-school learning were also part of the scope. Li et al. [49] investigated the mediating role of digital gaming environments on learners' vocabulary and motivation, and Lin et al. [17] reviewed mobile-assisted reading, focusing on the affordances of the tools for reading development and self-regulation. In addition, Zhang and Zou [21] as well as Zhang et al. [15] provided meta-analytical studies on peer feedback and TELL by examining the affordances of the tools used and their influence on feedback, reflective learning, learner outcomes, contradictions, and breakdowns of implementation.

In conclusion, the studies strengthen the argument for AT's usefulness in assessing the role of digital tools as learning mediators and not merely as delivery systems. Systems like LMS, AWE, Padlet, chatbots, AR, and mobile technologies intervene in the learning process as they configure the interplay among subjects (the learners), objects (the learning goals), and rules, often generating systemic conflicts that require pedagogical intervention. These findings corroborate the theory of AT that tools are not neutral; they actively change the systems within the activities and transform them through altering agency. AT also posits that tools are not neutral; they actively transform the learning system by redistribution of roles, reconfiguring interaction, and creating new possibilities and contradictions.

The synthesis of the studies in this review is presented in **Table 2**. It shows the classification of digital tools along with their mediational roles within the AT framework. This comparative perspective demonstrates how different technologies function as mediating artifacts to varying degrees in influencing the learner's participation, engagement, and educational results in diverse EFL and ESL contexts. To illustrate, the LMSs studied by Li and Xu [40], Van Nguyen and Habók [45], Rong and Yao [52], and Esnaashari et al. [53] revealed the systems' features to me-

diate access to course materials, feedback, and collaboration, which can help foster learner engagement. However, it also presented contradictions between pedagogical intent and actual usage. Such tensions illustrate the influence of institutional constraints and the distribution of roles within educational settings on the functionalities of the LMS.

Table 2. Comparative table of tool types and mediational effects.

Tool Type	Studies	Mediational Effects
LMS (e.g., Moodle)	Li & Xu (2023) [40], Van Nguyen & Habók (2021) [45], Rong & Dao (2024) [52], Esnaashari et al. (2025) [53]	Structure access to resources, support feedback cycles, mediate student engagement, surface contradictions
AI Tools (ChatGPT, Intelligent Tutors, AWE)	Chen et al. (2022) [9], Yang & Kyun (2022) [12], Li et al. (2025) [54]	Automate feedback, guide revision, foster learner agency, may generate contradictions
Digital Authoring Tools	Woo et al. (2024) [28]	Enable multimodal composition, support co-construction, promote peer creativity
Padlet	Min (2013) [19]	Support speaking practice, foster visual collaboration and real-time interaction
AR-based Games	Wang & Khambari (2020) [55]	Enhance contextual learning, encourage interactivity, shift roles
Digital Games (MMOGs)	Li et al. (2022) [49]	Promote vocabulary learning, learner autonomy, and motivation in informal settings
Peer Feedback Platforms	Lam (2021) [18], Zhang & Zou (2022) [21]	Facilitate peer-led revision, decentralize authority, foster reflection
CALL Tools	Hajimaghsoodi & Maftoon (2020) [14], Kessler (2020) [50]	Mediate writing process, enhance strategy use, support feedback cycles
MALL / Mobile Tools	Lin et al. (2020) [17], Yuliani et al. (2022) [56]	Scaffold learning, promote students' readiness to speak
TELL Tools (various)	Zhang et al. (2024) [15]	Mixed effectiveness; require pedagogical alignment and contextual fit

In addition, the use of AI-integrated tools of AWE systems, intelligent tutoring systems, and ChatGPT was investigated by Chen et al. [9], Yang and Kyun [12] and Li et al. [54], demonstrating the ability to automate feedback, assist in revision, and promote learner agency within language learning. Nonetheless, they also created contradictions where users' expectations or institutional norms misaligned with the capabilities of the tools. These tensions reinforce AT's emphasis on contradictions as the primary focus of change and expansive learning. The authoring tools examined by Woo et al. [28] and Min [19] with Padlet have assisted in the performance of speaking and writing tasks of multiple modes. As much as these tools broadened learners' expressive capabilities, they also changed the object of learning towards more cooperative peer scaffolding and visual collaboration. These tools changed the learners' roles as they became more independent and creative in the work being done. Conversely, Wang and Khambari [55] with AR learning environments, and Li et al. [49] with digital games and MMOGs, used game-based tools to mediate contextualized language use, vocabulary learning, and learner motivation. These tools turned learning into engaging and immersive activities while transforming students' roles into navigators of dynamic, user-guided experiences that demanded flexible, adaptive responses.

Studies by Zhang and Zou [21] and Lam [18] showed that peer assessment systems can decentralize students' responsibility and authority while promoting reflective writing, reshaping social norms and community structures. Hajimaghsoodi and Maftoon [14] and Kessler [50] reported CALL tools that went beyond basic writing mediation to offer strategic scaffolding, resources, and process restructuring. MALL tools in Lin et al. [17] supported reading and peer collaboration, particularly in self-directed or group

settings. At a meta level, Zhang et al. [15] noted mixed or negative impacts of TELL tools, emphasizing that without alignment between tool design, pedagogy, and learner readiness, digital tools risk fostering contradictions, redundancy, or disengagement

In these studies, mediational patterns were observed. Tools serve not only as facilitators but also as transformative mediators that change the object of learning, the learner's identity, and the activity system. They mediate interactions by shaping role distribution, engagement modalities, and task structuring. However, tools are only effective if they are properly integrated into pedagogical and institutional frameworks. Within the AT framework, successful use of digital tools by students relies not only on the tools' features but also on the placement of those tools within an integrated activity system that includes students, teachers, community, and interdependent relationships among the participants. These findings indicate that while LMSs and AWE tools create intentional spaces for learner participation, their utility hinges on their congruence with instructional objectives and student expectations. This requires educators to cultivate an awareness of possible discrepancies and to adopt a flexible, context-aware stance when embedding such technologies. For students, particularly in EFL environments, the introduction of these instruments prompts a recalibration of engagement and autonomy, compelling them to reconstitute their positions within the evolving activity system. The principal difficulty, therefore, resides in orchestrating digital mediation so as to uphold motivation, deepen collaborative practices, and advance critical language competencies.

Theme 3: The use of AT to examine language teachers' and learners' identity construction via the use of digital tools

The identity construction of an individual as a socio-culturally mediated process can be examined using AT. In the reviewed literature, there are several studies that apply AT to examine the impact of digital technologies on the identity transformation of teachers and learners within the context of specific cultures and institutions (**Table 3**).

Table 3. The use of AT to examine language teachers' and learners' identity construction via the use of digital tools.

Study	Context	Focus	Digital tool
Couture-Matté (2025) [57]	Elementary students designing VR scenarios	Learner identity construction through collaborative virtual world building	Build & show VR authoring tool
Esnaashari et al. (2025) [53]	University-level blended learning	Teacher identity shaped by contradictions in tool use	Web-based learning platforms, LMS
Kessler (2020) [50]	Graduate L2 writers	Identity and role transformation in writing via digital mediation	Computers, web-based writing tools, dictionaries
Kim & Kim (2021) [44]	EFL teachers navigating curriculum reform	Teacher identity, professional agency	Online teaching platforms, curriculum tools
Lam (2022) [58]	EFL pre-service teachers developing digital teaching competencies	Teacher professional identity and confidence	Digital teaching tools
Li & Xu (2023) [40]	Tertiary EFL teachers in China	Teacher identity transformation through expansive learning and agency	LMS, teacher development tools
Min (2013) [19]	Multimodal speaking using Padlet	Student identity construction through public sharing and collaboration	Padlet
Nazari & Karimpour (2022) [48]	EFL teachers in private language schools	Emotion labor, teacher identity	Instructional and assessment technologies
Woo et al. (2024) [28]	University students' digital multimodal composing	Learner identity as digital composers	Digital authoring and multimodal tools
Yang & Kyun (2022) [12]	AI-supported language learning review	Evolving learner roles and identities in AI-mediated environments or settings where AI shapes interaction, tasks, and outcomes.	AI tools, intelligent agents
Zhang & Zou (2022) [21]	Peer feedback in L2 writing	Negotiation of learner identity in feedback roles	Online peer review systems

Kim and Kim [44] found that curriculum reforms in South Korea prompted novice English teachers to negotiate between personal beliefs and institutional expectations, mediated by online tools. Nazari and Karimpour [48] reported similar identity shifts among Iranian EFL teachers, driven by emotional labor and digitally mediated practices. Li and Xu [40] showed that integrating digital and traditional practices in Chinese tertiary teaching created contradictions that fostered expansive learning and professional re-identification. Esnaashari et al. [53] highlighted identity conflicts in blended learning arising from tensions between pedagogical aims and tool affordances.

Studies on learner identity, such as Woo et al. [28] and Min [19], show how multimodal tools like authoring platforms and Padlet shift students' roles from passive recipients to designers, collaborators, and public communicators, reshaping academic and linguistic self-concepts. Zhang and Zou [21] reveal complex identity negotiations in peer review through role reversals, while Kessler [50] illustrates how tools like Mendeley and online dictionaries mediate learners' positioning as legitimate academic participants. At the elementary level, Couture-Matté [57] finds that collaborative virtual reality creation fosters identities rooted in authorship and agency. Synthesizing AI-assisted contexts, Yang and Kyun [12] demonstrate how AWE and intelligent tutors redefine learner roles, recalibrate control, and stimulate new forms of agency. Across these contexts, technological mediation compels learners to renegotiate their engagement with the activity system and navigate emergent forms of digital learner identity.

As a whole, these studies emphasize the pervasive influence of digital technologies as powerful mediators in the fluid and dynamic construction of identity under the AT sociocultural framework. Tools are not passive, neutral aids; they have rules that are built in, redefine roles within a community, and create contradictions that the participants are required to resolve. Together with the technologies they employ, learners and teachers reconstitute their identities and their relationships with others within the educational system. AT is particularly useful in examining identity because it reveals identity as an evolving construct within a tool-mediated, culturally situated activity system.

Theme 4: The use of AT to explore collaborative learning and peer feedback via digital platforms

The reviewed studies show a rise in research on collaborative learning and peer feedback in language education through AT (**Table 4**), framing learning as a socially mediated process of shared knowledge construction. Digital technologies can mediate interaction, feedback, and reflection, but their effectiveness depends on how they address contextual and systemic constraints. Lam [18] found that a web-based peer review system reduced cultural barriers and encouraged open feedback, yet also revealed misalignments between peer feedback practices and institutional rules. Overcoming such tensions requires more than technological provision; it calls for targeted scaffolding, structured training, and institutional adaptability to align expectations and enhance feedback's developmental impact.

Table 4. The use of AT to explore collaborative learning and peer feedback via the use of digital platforms.

Study	Context	Focus	Digital Platform
Chen et al. (2022) [9]	Collaborative writing in EFL classroom	Learner collaboration and feedback processes	Online shared writing tools
Fazza (2021) [47]	AFL learners in Qatar	Peer feedback and collaborative reading	Perusall
Lam (2021) [18]	Web-based peer review in teacher education	Peer feedback and role shifts during practicum	Web-based peer review system
Min (2013) [19]	Speaking practice using Padlet	Collaborative speaking and visual interaction	Padlet
Woo et al. (2024) [28]	University students' multimodal writing	Peer collaboration in digital composition tasks	Digital authoring tools

Table 4. *Cont.*

Study	Context	Focus	Digital Platform
Yang & Kyun (2022) [12]	Systematic review of AI-supported language learning	Collaboration in AI-mediated feedback environments	AI platforms and agents
Zhang & Zou (2022) [21]	Review of peer feedback in L2 writing	Roles, strategies, and negotiation in feedback	Online peer feedback platforms (technology-enhanced peer feedback -TEPF)
Zhang et al. (2024) [15]	Review of TELL with null/negative results	Challenges in digital collaboration	Various TELL platforms

Zhang and Zou [21] reviewed TEPF in L2 writing, highlighting the importance of role clarity, interaction maintenance, metacognition, and tool affordances. Such platforms not only deliver feedback and instruction but also enable identity and role shifts as students act as both writers and reviewers. Collaborative writing studies show that digital authoring and multimodal tools facilitate joint meaning-making, with task assignments adapting to evolving learner roles [9,28]. In oral tasks, tools like Padlet support plan visualization and collaborative expression, while Min [19] notes the tension between individuality and group cohesion. Similar patterns appear in AI-mediated environments, where intelligent agents can enhance feedback yet reduce proximity contact [12].

In addition, by investigating collaborative reading and peer feedback within AFL contexts utilizing Perusall, Fazza [47] extended this line of research, showing how annotation tools facilitate dialogic learning and peer-mediated understanding. However, tensions were also uncovered with inequitable roles and the clarity of feedback provided. Finally, Zhang et al. [15] reviewed a broader range of TELL platforms and highlighted instances of collaboration breakdown due to tool construction conflicts, misalignment with the instructional goals, or internal systemic contradictions, such as those between tool affordances and learner readiness.

These studies support AT's applicability in examining how tools, roles, and social relations shape collaborative learning, highlighting the dual enabling and constraining effects of digitally mediated interaction within activity systems. As for the contradictions arising from such systems, they can lead to conflicts that serve as catalysts for transformative learning, which compels both learners and educators to modify their practices, roles, and understandings.

Theme 5: The use of AT to investigate language learning in blended and online environments

Several studies used AT to examine language learning in blended and online contexts, focusing on curriculum, LMS, assessment, and participant roles in MOOCs. Li [22] showed that performance improves when all elements of the activity system align, framing the tension between online flexibility and classroom structure as productive. Jitpaisarnwattana et al. [59] similarly noted low engagement in language MOOCs when instruction was limited to teacher-light delivery without direct interaction. These findings stress the need for mediating tools to align with learner expectations and be embedded in scaffolded frameworks that sustain engagement.

Other scholars investigated the blended and online learning paradigms, focusing on the role of teacher agency in balancing organizational culture, learner behavior, and technology. As noted by Rong and Yao [52] and Rahnuma [60], AT was applied to show how teachers adapt to different dialectical modalities and learner groups, while Van Nguyen and Habók [45], and Li and Xu [40] focused on the use of learning management systems. These studies revealed digitally enhanced systems and learners' expectations as opposing forces, reinforcing the need for adaptive teaching and scaffolding strategies in pedagogy. In addition, Alshakhi [46] and Rouabhia [61] examined the resulting shift in content delivery and interaction caused by digital platforms, while Sors et al. [62] studied how serious games can be employed to motivate and engage learners. As noted by Esnaashari et al. [53] and Zhang et al. [15], effective blended learning is not simply the addition of technology. Meaningful engagement requires an enduring alignment of tools, pedagogical objectives, user practices, and integration beyond the surface level.

Li et al. [54] also looked at Chinese universities to find

the main contradiction among learner agency, overreliance on instructional tools, institutional evaluation standards, and mobile vocabulary learning via chatbots. The study concluded on how mobile-supported environments facilitated learning disruptions that necessitated the intentional alignment of tools to prevent learner demotivation. Previously, Lin et al. [17] synthesized 28 studies on assisted reading, concentrating on context-aware tool use. They argued that mobile technologies foster autonomy and engagement but also create tensions around self-regulation and instructional support, illustrating their mediating role in online and hybrid learning.

Overall, these findings underscore AT's value in revealing how tools mediate learning across physical and virtual contexts. Contradictions between learner autonomy and institutional frameworks emerge as catalysts for change, with AT highlighting how participants navigate tensions, adapt practices, and achieve improved educational outcomes in blended and online settings.

Theme 6: The application of AT to examine mediated learning and tool-mediated behaviors

Table 5 below contains several studies that use AT to explore the role of specific tools in mediating learning processes. It includes the context of each study as well as the tool used (e.g., Padlet, ChatGPT, AR apps) and the mediated learning component, such as revision behavior, collaborative learning, motivation, or identity work.

Table 5. The use of AT to examine mediated learning and tool-mediated behaviors.

Study	Context	Tool	Mediated Aspect
Chen et al. (2022) [9]	Collaborative EFL writing	Online writing platforms	Interaction and co-construction of knowledge
Esnaashari et al. (2025) [53]	Blended learning at university	LMS and web tools	Student engagement and contradictions
Fazza (2021) [47]	AFL reading via Perusall	Perusall	Peer collaboration, reading strategy development, division of labor
Hajimaghsoodi & Maftoon (2020) [14]	CALL for writing improvement	CALL tools	Writing proficiency and scaffolding
Lam (2021) [18]	L2 writing feedback	Web-based peer review platform	Response to teacher/peer feedback, community roles, and cultural norms
Li (2022) [22]	Blended EFL course at university	LMS, digital modules	Academic performance and engagement
Lin et al. (2020) [17]	MALL-based reading	Mobile devices	Reading development, learner autonomy, collaborative strategies, self-regulation
Min (2013) [19]	Multimodal speaking tasks	Padlet	Collaborative speaking and idea generation
Rahimi et al. (2024) [20]	University EFL speaking tasks	ChatGPT	AI-mediated feedback and speaking engagement
Wang & Khambari (2020) [55]	AR in sentence construction	AR-based mobile app	Learner motivation and task completion
Woo et al. (2024) [28]	Multimodal composition tasks	Digital authoring tools	Learner creativity and identity
Yuliani et al. (2022) [56]	English language teaching for higher education students	Mobile phones	Readiness for speaking
Zhang et al. (2024) [15]	TELL tool review with negative outcomes	Various TELL platforms	Learning outcomes and contradictions

As noted before, AT is grounded in the principle that learning occurs with the mediation of tools, whether they are technological, symbolic, or pedagogical in nature. Devices of learning are not passive but active mediators within intricate activity systems, performing scaffolding functions for different components of language learning. For

example, Esnaashari et al. [53] showed that LMSs were instrumental to student engagement and academic success in blended university courses, even while exposing contradictions between system affordances and learner expectations. Findings parallel those of Chen et al. [9] and Min [19], who showed that collaborative tools such as Padlet and shared writing tools fostered peer interaction, enabling them to actively engage in knowledge construction and thus transforming the learners' division of labor.

Furthermore, Rahimi et al. [20] showed how AI technology might be used even further. The study investigated ChatGPT's function as a mediating instrument in speaking and writing tasks, particularly enhancing learners' willingness to engage in communication via ChatGPT-mediated speaking activities. However, conflicts emerged in both instances. While AI increased learner agency, there was also the danger of fostering overdependence or diluting face-to-face interaction. Such tensions align with AT's secondary contradictions. Along similar lines, Hajimaghsoodi and Maftoon [14] focused on the use of CALL to scaffold writing skills, pointing out conflicts and alignments brought about by digital mediation.

Focusing on specialized affordances, Wang and Khambari [55] developed AR-based mobile applications for interactive sentence construction. Yuliani et al. [56] proved the students' readiness in m-learning, which supports the development of speaking skills. Most notably, Zhang et al. [15]'s review pointed out that not all tool-based learning is beneficial. There are contradictions, such as misalignment between the instructional design and the learner's context, needs, and stagnating learning if these factors are ignored.

In summary, these studies reaffirm a central tenet of AT: tools are integral to the activity system and actively shape the learning process. Far from being passive conduits, tools exert transformative influences since they scaffold cognitive and social development when well-aligned or generate systemic tensions when misaligned. Such tensions demand recalibration of the broader activity system, underscoring the need for pedagogically coherent integration. By conceptualizing learning as inherently tool-mediated, AT equips researchers and practitioners to critically trace how educational technologies can both enable and constrain the achievement of pedagogical objectives.

Theme 7: The use of AT to reveal contradictions and tensions in language teaching and learning in digital environments

Focus on contradictions as opposing forces and change catalysts stands out under the Activity Theory rubric. Rather than marking failure, contradictions are conceptualized as creative tensions that arise within or between an activity system component, for example, tools and rules or community norms with object-oriented actions. The studies included in this review convincingly illustrate the importance of this perspective in revealing structural and pedagogical misalignments in technology-mediated language education (**Table 6**).

Table 6. The use of AT to reveal contradictions and tensions in language teaching and learning in digital environments.

Study	Context	Contradiction or Tension
Rahnuma (2023) [60]	ESL students' experiences of academic writing in higher education	Tertiary contradictions: new writing practices displaced familiar habits, forcing students to redefine their academic identities. Ask ChatGPT
Esnaashari et al. (2025) [53]	University blended course	Mismatch between teacher intentions and student digital practices
Guo et al. (2024) [43]	AI chatbot-assisted EFL writing	Tool limitations and lack of collaborative scaffolding; students required external tools to supplement the chatbot, revealing secondary contradictions between tool capabilities and learner needs
Hajimaghsoodi & Maftoon (2020) [14]	CALL in writing instruction	Technological tool limitations vs. pedagogical aims
Jitpaisarnwattana et al. (2022) [59]	LMOOC participation	Personalized learning needs vs. lack of teacher presence
Lam (2021) [18]	Peer feedback in teacher education	The gap between peer feedback expectations and perceived quality

Table 6. *Cont.*

Study	Context	Contradiction or Tension
Li et al. (2022) [49]	Game-based out-of-school EFL learning	Multiple contradictions: tool-object mismatch, lack of gaming skills, subject-rule misfit, and evolving learning focus from gameplay to language development
Li (2022) [22]	Blended EFL learning	Tension between online flexibility and classroom structure
Min (2013) [19]	Speaking practice via Padlet	Tension between individual creativity and group coherence
Yang & Kyun (2022) [12]	AI-mediated language learning	Limited human interaction and tool misalignment with pedagogical needs
Zhang & Zou (2022) [21]	Peer feedback in L2 writing	Tension in peer roles and uneven engagement
Zhang et al. (2024) [15]	Review of ineffective TELL studies	Tool functionality does not meet learner or instructor expectations

In Li [22]'s study, a clear contradiction emerged between students' expectations for scheduling flexibility in a blended EFL course and the rigid timetabling characteristic of traditional EFL classes. This misalignment, evidenced by learner disengagement and sporadic attendance, underscores the need for dialogic renegotiation of learning frameworks to align institutional structures with learner needs. Similarly, Esnaashari et al. [53] identified parallel tensions in a New Zealand university, where the pedagogical intentions behind LMS integration frequently diverged from students' actual engagement patterns. These findings reveal a subordinate contradiction within the activity system, where pedagogical aims collide with rule-bound compliance, necessitating systemic adjustments to reconcile instructional design with authentic learner practices.

The integration of AI into educational environments presented novel opportunities to examine system disturbances. Yang and Kyun [12] noted a disconnect between the use of personalized AI feedback and its contextual nuances (or lack thereof) in relation to teaching and learning objectives. Moreover, in their analysis of chatbot-aided writing, Guo et al. [43] found that students often looked for outside feedback to make up for what automation could not do, which showed that the tools did not always meet the learners' expectations.

The domain of peer interaction and feedback has expanded; still, several studies positioned these contradictions within that domain. As reported by Lam [18] and Zhang and Zou [21], while peer review interfaces harnessed by technology granted users universal access to formative evaluation, they simultaneously imposed new conflict lines around evaluative jurisdiction and the trustworthiness of comments given. Such disruptions led to the undoing of the intended peer review function as scaffolded mutual exchange. In another case, Min [19] documented how the balance between learner autonomy and the collective coherence goal in group presentations created conflict, illustrating a third-order contradiction between participants' evolving self-concepts as learners and the joint communicative aims.

Learner objectives also evolved in informal contexts such as game-based environments. Li et al. [49] found that language learners in online gaming communities experienced tensions when their focus shifted from gameplay to language acquisition, prompting expansive learning. At an institutional level, Jitpaisarnwattana et al. [59] noted that while LMOOCs increased language learning access, limited content and lack of instructors reduced engagement. Zhang et al. [15] further showed that poorly integrated digital resources could hinder or even reverse learning outcomes.

Using Engeström's typology, various scholars have explored different forms of contradictions within technology-enhanced language learning. In her study, Li [22] illustrated secondary contradictions where the blended language learning technologies' constraints and affordances at times worked against the attainment of user goals and instructional expectations. Besides, the study on identity change among teachers and students by Rahnuma [60] provided proof of tertiary contradictions arising from the replacement of academic writing paradigms with more modern frameworks, creating conflict with established

teaching structures. In the same way, Li et al. [49] identified quaternary contradictions arising from the self-directed, informal nature of game-based language learning conflicting with the formal, structured academic curricula and its rigid expectations.

The analytical lens provided by an educative system's technology enables the identification and interrogation of contradictions embedded within technology-mediated learning processes. Rather than treating these tensions as incidental, scholars conceptualize them as systemic anomalies that, if critically engaged with, demand deliberate pedagogical recalibration and structural reform. From an AT perspective, learning emerges as a dynamic and mediated phenomenon shaped by the interplay of tools, actors, and contexts. This framing highlights the complexity of how participants navigate, resist, or transform activity systems in response to disturbances, while underscoring the need to harness such contradictions as drivers of sustainable educational change.

Overall, the themes generated in the review lend themselves to a coherent explanatory framework when examined through the lens of contradiction types, as denoted in **Figure 4**, which showcases the structural tensions operating within and across the activity system and their influence on digital language learning practices. Secondary contradictions were most prevalent, manifesting when technologies, specifically, AI chatbots, mobile applications, and LMSs, clashed with prevailing institutional rules and established norms [43,52,55]. This was especially pronounced in investigations that examined teacher-student interaction and tool-mediated learning (themes 1 and 2). These tensions often disrupted established routines and prompted adaptations in both pedagogical roles and communicative practices. Tertiary contradictions were evident in well-documented themes of identity construction and collaborative learning (themes 3 and 4), for examples, issues of unequal participation and unclear feedback emerged [47], breakdowns in collaboration stemming from tool design issues, misaligned goals, and learner-tool mismatches [15], tensions between personal beliefs, institutional norms, and technological mediation [40,44,48] arising from digital integration in teacher education, and identity conflicts in blended learning settings [53] where tool affordances clashed with pedagogical intentions. Quaternary contradictions were most pronounced within studies of blended and fully online models (themes 5 and 6), where learners confronted diverging expectations generated by formal institutional contexts and informal learning environments. The clash between community norms and divisions of labor was particularly tangible in collaborations oriented toward peer contribution, thereby illuminating negotiated changes in roles and accountability. Finally, tensions from technology integration synthesize disturbances that, rather than obstructing, act as catalysts, creating opportunities for expansive learning and driving pedagogical transformation. Consequently, the activity system remains dynamic, continually adapting as the tensions embedded within its structural components accumulate and give rise to contradictions.

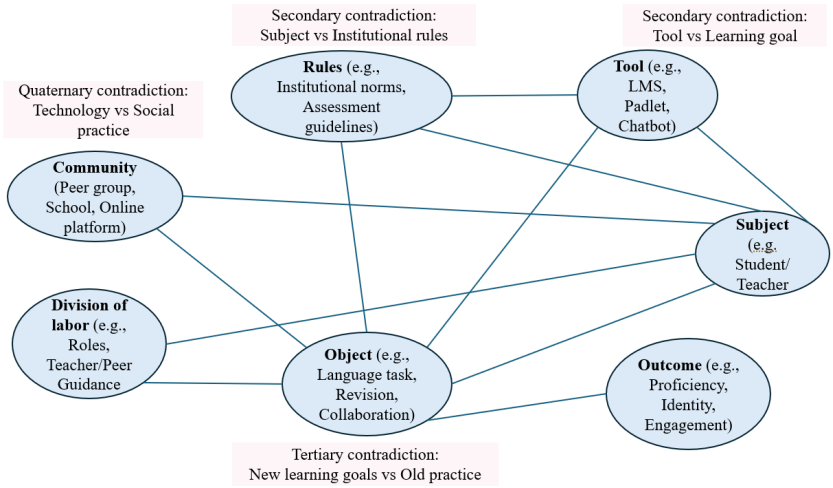

Figure 4. Types of contradictions in AT as identified across the reviewed studies.

Tertiary contradictions become apparent when emergent digital routines confront entrenched pedagogical epistemes, driving ongoing negotiations of identity among both learners and educators. Tools that support peer commentary or multimodal artefact production challenge established norms, creating dissonance while fostering professional growth and rethinking learning objectives.

The review further identifies quaternary contradictions that arise within blended learning contexts, wherein formally governed digital platforms and informal learning ecologies present divergent claims. Learners experience sustained difficulty reconciling institutional imperatives with the pragmatics of home environments, thereby illuminating the capacity of cross-system tensions to condition, or reconstrue engagement. Through all examined cases, contradictions do not operate as impediments but rather as incitements to procedural adaptation and expansive learning.

Overall, the synthesis shows interconnected patterns of technological mediation, systemic contradictions, and identity negotiation across diverse contexts and study designs (**Figures 2–4**; **Tables 1–6**). Geographic and institutional distributions of research (**Figure 2**; **Table 1**) align with thematic emphases (**Table 2**) and pedagogical contexts (**Table 3**), demonstrating how regional priorities and institutional infrastructures shape the integration and functionality of mediating tools. The technological categories in **Table 4**, when read alongside the interactional configurations in **Figure 3**, reveal that collaborative and feedback-oriented practices (**Table 5**) are often intertwined with identity-shaping processes (**Table 6**), where alignment or misalignment between tools and pedagogical intentions can catalyze adaptive shifts within activity systems. **Figure 4** further visualizes the thematic clusters emerging from these patterns, reinforcing the interdependence of micro-level classroom practices and macro-level policy or infrastructure conditions. In other words, **Figures 2–4** and **Tables 1–6** together illustrate how digital mediation reconfigures engagement, systemic contradictions prompt structural recalibration, and evolving identities reshape learner and teacher roles in the context of educational technology.

5. Conclusions

This systematic review explored how AT has been used to analyze the mediation of digital technologies in language education through 35 empirical studies published between 2020 and 2025. The review spans various geographical distributions and learning contexts, illustrating the utility of AT for understanding and analyzing complicated sociocultural systems influenced by digital mediation.

Across the themes identified in this review, recurring connections and contradictions emerge that hold significant implications for pedagogy and policy. For example, while AI-mediated and blended learning environments (**Tables 3–5**; **Figures 2–4**) promote learner autonomy and multimodal engagement, they also expose systemic tensions between institutional norms, technological affordances, and learner expectations. Similarly, studies on collaboration, identity, and feedback (**Tables 4–6**) reveal that the same tools enabling participation can reproduce inequities when infrastructure, training, or cultural factors are misaligned. These cross-theme patterns underscore the need for pedagogical frameworks that scaffold both technical and social dimensions of tool use, and for policy measures that ensure equitable access, context-sensitive integration, and sustained professional development to bridge the gap between innovation and practice.

The reviewed studies reveal a consistent dynamic in which digital technologies simultaneously empower and limit instructional practices. Educators increasingly assume the role of moderators of digital participation rather than sole purveyors of content, balancing institutional mandates with the demands of student agency. At the same time, students move from passive receptors to active co-producers of knowledge within environments saturated by digital affordances. These shifts, however, are not homogeneous; they are shaped by the particulars of local settings, variability in access, and the architecture of the digital tools. A central implication arising from the reviewed papers is that professional development should cultivate in teachers not only technical skills, but also a robust conceptual vocabulary for adjudicating the contradictions that emerge, most notably, the discord between the capabilities of platforms and the readiness of learners, while simultaneously attending to the development of learner identity and the fostering of autonomy. Through this review, the digital mediation in language education is found not only a technological

concern but also a deeply pedagogical one. In this particular digital environment, instructors need to adjust their instructional duties and configure their teaching practice, while learners need to reshape their agency within multilayered, digitally enriched contexts. Attending to these interrelated processes is essential for developing curricula to make them both resilient and responsive, thereby promoting language proficiency in environments where digital and pedagogical elements are inextricably woven.

While this review has provided a comprehensive mapping of how AT has been applied in technology-mediated language education, it moves beyond a descriptive catalogue by interrogating the theory's analytical affordances and limitations. In synthesizing the findings, it becomes evident that several studies employed AT primarily as an organizing heuristic, without fully engaging with its dialectical underpinnings, particularly the dynamic interplay of contradictions, mediation, and expansive learning. This review extends theoretical critique by foregrounding how AT's structural components sometimes risk reifying categories (e.g., subject, object, tool) unless researchers actively theorize the fluidity and mutual transformation of these elements over time. Moreover, the synthesis reveals underexplored tensions between AT and adjacent frameworks in educational technology research, such as socio-material theory or distributed cognition, which could enrich analyses of tool-mediated practices. By situating AT in dialogue with these perspectives, future research can better capture the emergent, multi-faceted nature of digital learning ecologies. Thus, the contribution of this review lies not only in documenting applications of AT but also in advancing its critical use, highlighting conceptual blind spots, encouraging reflexivity in theoretical framing, and proposing pathways for deeper, more contextually attuned AT-based inquiry.

This review has underscored the continued analytical potency of AT when investigating the mediation of language learning by digital instruments, including AI-driven applications, across diverse sociocultural environments. By concentrating on the interconnected domains of subjects, tools, objectives, rules, communities, and division of labor, AT furnishes a dynamic vantage from which pedagogical reconfiguration can be traced. Its particular emphasis on contradictions as fermenters of expansive learning allows scholars to map developmental changes that extend beyond practices to encompass entire activity systems. Such a scope contrasts with the comparatively instrumental focus of models like Technological Pedagogical Content Knowledge (TPACK) [63], the Unified Theory of Acceptance and Use of Technology (UTAUT) [64], and Sociocultural Theory [8], which, despite their merits, do not consistently foreground the historically mediated, collective reconfiguration that AT renders explicit.

As AI technologies gain salience, the emerging framework of Human-AI Collaboration (HAIC) [65] provides parallel, and perhaps complementary, illumination. HAIC foregrounds the reciprocal augmentation of human and AI agents, adaptive division of labor, and the efficiency and trust that undergird effective interaction. Crucially, however, the framework seldom addresses the wider institutional and identity repercussions of tool deployment, domains in which AT has accumulated more substantive interpretive purchase. Conversely, AT's conceptual armature remains comparatively mute on the nuanced agency, opacity, and contingent personalization capacities that contemporary AI systems introduce. A deliberate synthesis of AT's macro analytical reach with HAIC's granular focus on micro-interactional dynamics is, therefore, a productive avenue for future scholarship, promising a more integrated account of the systemic reconfigurations and situated user experiences that contemporary digital learning increasingly embodies.

Looking forward, future studies would be enhanced by more deeply exploring contradictions within pedagogy, policy, and platform design at various levels, and applying AT's dialectical frameworks. In particular, longitudinal research that examines expansive learning over time may reveal more about the enduring impacts of digital mediation on the education system. In any case, AT continues to be a productive and developing framework with the potential to explain the multifaceted relationships among tools, people, and the learning process, especially within deeply digitized education systems.

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Not applicable.

Data Availability Statement

This study is a systematic review and does not report any original data. All sources used are publicly available and fully cited in the reference list.

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Conflicts of Interest

The authors declare no conflict of interest.

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