

Smartphone-Mediated Informal English Learning Within Learners' ZPDs¹

Aprendizagem Informal de Inglês Mediada por Smartphones nas ZDPs dos Aprendizes

Flávio Augusto dos Santos Pinto²

Abstract

This study investigates how smartphones mediate learning processes within learners' Zones of Proximal Development (ZPDs) among Brazilian English majors. A mixed-methods design combined a questionnaire (n = 220), semi-structured interviews, smartphone screen recordings, and analysis of interactions in a WhatsApp group. The findings indicate that learners primarily engage in human-computer interactions, including algorithmic feedback, multimedia input, and digital language tools. These interactions predominantly support receptive skills such as reading and listening and foster self-regulation through the gradual internalization of linguistic knowledge. Interpersonal mediation through smartphones occurs less frequently and is largely asynchronous and text-based, limiting opportunities for synchronous collaborative scaffolding. Although smartphones offer valuable affordances for self-directed language learning, they do not fully replace the developmental benefits of direct human interaction. The study highlights the need for pedagogical initiatives that integrate smartphone-mediated practices with interactive and productive language activities, enabling learners to expand ZPDs beyond algorithmic mediation.

Keywords: CALL. Smartphones. Informal English learning. ZPD.

Resumo

Este estudo investiga como os smartphones medeiam processos de aprendizagem dentro das Zonas de Desenvolvimento Proximal (ZDPs) de estudantes brasileiros de graduação em inglês. Uma abordagem de métodos mistos combinou um questionário (n = 220), entrevistas semiestruturadas, gravações de tela de smartphones e análise de interações em um grupo do WhatsApp. Os resultados indicam que os aprendizes se engajam principalmente em interações humano-computador, incluindo feedback algorítmico, *input* multimodal e ferramentas digitais de linguagem. Essas interações facilitam predominantemente habilidades receptivas, como leitura e escuta, e favorecem a autorregulação através da internalização gradual do conhecimento linguístico. A mediação interpessoal por meio de smartphones ocorre com menor frequência e é em grande parte assíncrona e baseada em texto, o que limita oportunidades de *scaffolding* colaborativo síncrono. Embora os smartphones ofereçam *affordances* valiosas para a aprendizagem autodirigida da língua, eles não substituem completamente os benefícios desenvolvimentais da interação humana direta. O estudo destaca a necessidade de iniciativas pedagógicas que integrem práticas mediadas por smartphones a atividades linguísticas interativas e produtivas, permitindo que os aprendizes ampliem ZDPs para além da mediação algorítmica.

Palavras-chave: CALL. Smartphones. Aprendizagem informal de inglês. ZDP.

1 Introduction

Brazilian higher education has expanded significantly in recent decades through policies aimed at widening access, particularly affirmative action initiatives. As a result, universities now serve a more socioeconomically diverse population (FONAPRACE, 2019; Pinheiro et al., 2021). This transformation

¹ This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) – Finance Code 001.

² Doutor em Letras. Universidade de São Paulo, São Paulo, São Paulo, Brasil. Orcid: <https://orcid.org/0009-0003-1803-4225>
E-mail: flavioaugustodossantospinto@gmail.com.

has highlighted inequalities in access to English language education, since many students entering teacher education programs have had limited opportunities for prior instruction, often due to restricted access to private language courses (Borges & Garcia-Filice, 2016).

In response, students increasingly rely on self-directed learning practices outside formal classrooms. Digital platforms such as streaming services, social media, and language-learning applications provide opportunities for regular exposure to English. Smartphones play a central role in this process because they constitute the main means of internet access for most Brazilians (NIC.br, 2023).

From a sociocultural perspective, learning occurs through mediated activity involving interaction with peers or with cultural artifacts. The concept of the Zone of Proximal Development (ZPD) describes the distance between what learners can accomplish independently and what they can achieve with assistance (Vygotsky, 1978). Technologies such as smartphones may function as mediational tools (Figueiredo, 2019) that support learning within learners' Zones of Proximal Development (ZPDs) by providing feedback, resources, and opportunities for interaction. Despite growing research on Computer-Assisted Language Learning (CALL), studies examining smartphone-mediated English learning in informal³ contexts remain limited, particularly in Latin America (Persson & Nouri, 2018; Qin & Ren, 2021). Therefore, this study addresses the following research question: *How do smartphones mediate English learning within the ZPD of Brazilian English teacher education students in informal contexts?*

2 Literature review

Within the broad domain of Computer-Assisted Language Learning (CALL), studies have historically drawn on a wide range of technologies, from desktop computers and laptops to portable devices such as MP3 players, personal digital assistants (PDAs), and mobile phones. Successive refinements have defined more specific areas of inquiry. Mobile-Assisted Language Learning (MALL) arose as a subfield focusing on portable devices such as laptops, tablets and mobile phones. Leis et al. (2015) proposed the term Smartphone-Assisted Language Learning (SPALL) to encompass both smartphones and tablets used for educational purposes. Further narrowing the scope, Luo and Watts

³ Different educational contexts can be classified as formal, non-formal, or informal (Marandino, 2017). Formal education refers to planned educational processes conducted by an educator within a formal learning environment; non-formal education occurs outside formal institutions but still has clearly defined educational objectives; and informal education consists of unplanned learning that arises naturally from individuals' life experiences. For the purposes of this study, informal education refers to both non-formal and informal processes, that is, educational processes that take place outside the classroom.

(2022) introduced Smartphone-Assisted English Language Learning (SAELL) to emphasise the privileged position of English in digital environments while still centring on smartphones. The present study adopts the acronym SPAELL, which merges the smartphone-centered orientation of SPALL with the English-specific focus of SAELL, while further restricting its scope to the exclusive use of smartphones for English-language learning. This choice is justified by the unparalleled integration of smartphones into daily life, which Godwin-Jones (2017) describes as their having become “digital appendages” (p. 4), and by the need to avoid the “mixing of apples and oranges” (p. 5) that often occurs when different types of mobile devices are bundled together in broader MALL research.

2.1 Smartphone-Assisted English Language Learning

Over the past decade, research on Smartphone-Assisted English Language Learning (SPAELL) has expanded alongside the growing presence of these devices in everyday life. Studies consistently show that smartphones support learner autonomy, engagement, and access to authentic linguistic input across formal, non-formal, and informal contexts (Hidayati & Endayani, 2019; Luo & Watts, 2022; Mengjie et al., 2021). Through applications, messaging platforms, and multimedia content, learners engage with English beyond traditional classroom boundaries.

Most research focuses on university students in English as a Foreign Language (EFL) or English Language Teaching (ELT) programs. Across contexts such as Southeast Asia, Europe, and the Middle East, learners commonly use smartphones to access digital resources, watch videos, consult dictionaries and translation tools, participate in messaging exchanges, and complete exercises in language-learning applications (Jurkovič, 2019; Sierocka et al., 2019; Şad et al., 2022). These findings suggest that smartphones extend language engagement into everyday activities and personal interests.

2.2 Mediation and Sociocultural Perspectives

While early Mobile-Assisted Language Learning (MALL) research emphasized technological affordances (Gibson, 1986; van Lier, 2000) and learner motivation, more recent work has explored the cognitive and social dimensions of smartphone-mediated learning. From a sociocultural perspective, language development occurs through mediated activity involving social interaction and cultural artifacts (Figueiredo, 2019; Lantolf, 2000; Vygotsky, 1978). Within this framework, technological tools can

function as mediational means that support learning within learners' Zones of Proximal Development (ZPDs).

Although many studies do not explicitly reference the ZPD, their findings can be interpreted through this lens. Smartphone environments often provide mediation resembling scaffolding processes, including automated feedback, collaborative interaction, and adaptive tasks. For example, reading applications may offer immediate linguistic feedback, enabling learners to perform tasks slightly beyond their current competence (Wang et al., 2018), while messaging platforms can facilitate peer feedback and negotiation of meaning (Luo & Watts, 2022).

Smartphones also support learner autonomy and self-regulation, as students frequently use dictionaries, translation apps, and grammar checkers to monitor language production and resolve comprehension difficulties (Putrawan & Riadi, 2020). However, the effectiveness of such mediation depends on contextual factors such as technological access, digital literacy, and learners' capacity for self-directed learning.

2.3 Research Gaps

Despite the growing body of research on Mobile-Assisted Language Learning (MALL), several gaps remain. First, much of the literature focuses on formal educational settings or structured classroom activities, while fewer studies examine smartphone use in informal learning environments (Godwin-Jones, 2017; Rosell-Aguilar, 2017). Yet these contexts are increasingly significant, as learners frequently engage with language through everyday digital practices such as social media, online videos, and messaging applications.

Second, existing research is geographically concentrated in Asian and European contexts. Latin America remains underrepresented in the global body of MALL research (Persson & Nouri, 2018), leaving limited empirical evidence regarding how sociocultural conditions in this region shape mobile-mediated language learning.

Finally, relatively few studies analyze Smartphone-Assisted English Language Learning (SPAELL) through a sociocultural framework (e.g., Luo & Watts, 2022) that explicitly addresses mediation and learning within the Zone of Proximal Development (ZPD). Investigating how learners use mobile technologies to receive mediation, regulate their learning, and engage in social interaction may therefore contribute to a deeper understanding of the cognitive and developmental processes involved in SPAELL.

Addressing these gaps, the present study examines how smartphones mediate English learning within the ZPDs of Brazilian English teacher education students in informal contexts. By analyzing learners' smartphone-mediated learning through a sociocultural lens, the study seeks to better understand how digital mediation supports cognitive development and language learning beyond the classroom.

3 Methods

This study employed a mixed-methods design combining a questionnaire, interviews, screen recordings, and analysis of interactions in a WhatsApp group. Participants were undergraduate students enrolled in English or Portuguese–English Language and Literature programs at public higher education institutions (HEIs) across Brazil.

In the first phase of the study, a total of 220 students from 38 public HEIs across 19 Brazilian states, covering all five geographical regions of the country and the Federal District, completed an online questionnaire. Invitations to participate were sent via email to course coordinators at these institutions, who were asked to distribute the invitation and questionnaire link to students through institutional mailing lists. Most participants were aged 18–24 (64%, $n = 141$), followed by 25–40 (30.5%, $n = 67$), 41–60 (5%, $n = 11$), and over 60 (0.5%, $n = 1$). Regarding gender, 70.9% ($n = 156$) identified as female, 28.2% ($n = 62$) as male, and 0.9% ($n = 2$) as other.

Within the questionnaire, items specifically addressing the potential construction of Zones of Proximal Development (ZPDs) asked participants to indicate the predominant type of interaction they engaged in (human–computer⁴ or interpersonal), followed by questions on the frequency of interpersonal interactions, their usual synchronicity (synchronous, asynchronous, or both), and the communication medium employed (written, audiovisual, or both). These items served to map the kinds of mediational partners (i.e. technological artifacts or other people) through which learners potentially operated within their ZPDs.

In the second phase of the study, five participants (one from each Brazilian region) were randomly selected from a pool of 74 volunteers who had expressed willingness to participate in the subsequent phases of the study in the questionnaire. These participants took part in semi-structured interviews conducted online, which were transcribed for analysis. The semi-structured interview protocol

⁴ The term 'human–computer interaction' is adopted here in line with the established field of Human-Computer Interaction (HCI) in language learning (e.g., Caws & Hamel, 2016), where the computer functions not merely as a machine but as a cultural artifact mediating semiotic activity, a concept fully consistent with the sociocultural framework that underpins this study (Vygotsky, 1978).

included an axis dedicated to the construction of ZPDs. Under this axis, guiding questions such as “How do you learn English through your smartphone? Give examples” were used to elicit detailed descriptions of the mediational processes, the types of assistance learners sought, and how they progressively moved from regulation by technology or more capable peers towards greater self-regulation in the target language.

In the third phase of the study, participants submitted smartphone screen recordings documenting their interactions with English-learning applications and digital resources. These recordings were sent by email and consisted primarily of qualitative data. To capture participants’ learning processes in a holistic manner, the recordings were analyzed through a thematic approach developed for this study. Detailed descriptions of participants’ actions were produced based on screenshots taken at key moments in the videos. These descriptions served as the basis for identifying themes related to mediation, learner behavior, and interaction with digital tools.

In the fourth phase of the study, a WhatsApp group involving 27 participants was created to observe peer-mediated communication in English. These participants were self-selected from among the 220 respondents who had completed the questionnaire. The WhatsApp group remained active for one year, but yielded limited interaction. Most interaction occurred during the first three days after the group was created, during which 98 messages were exchanged. After this initial period, no further interaction was recorded. No intervention was carried out by the researcher because the objective was to observe participants’ communication patterns naturalistically, allowing interaction, or the absence of it, to emerge without external prompting.

Quantitative data were analyzed using simple descriptive statistics (percentages and total number of participants), while qualitative data were analyzed through thematic analysis (Braun & Clarke, 2013), focusing on processes of mediation, self-regulation, and peer interaction.

4 Results

4.1. Learning within the Zone of Proximal Development: Insights from the Questionnaire Data

The questionnaire data suggest two main types of learning within the Zone of Proximal Development (ZPD) (Lantolf, 2000; Vygotsky, 1978) emerging through Smartphone-Assisted English Language Learning (SPAELL). The first involves human–computer interaction, in which learning activities are mediated primarily by technological tools or algorithms. In these cases, learners engage with cultural artifacts (Cole, 1998) that provide semiotic mediation through automated feedback, digital

resources, and multimedia input. The second involves interpersonal interaction, in which mediation occurs through communication with other individuals.

These forms are not mutually exclusive. Many learners combine human-computer and interpersonal mediation, moving between individual interaction with digital tools and communication with others. Such hybrid practices indicate that learners seek mediational support that enables them to expand their Zones of Actual Development (ZADs) and navigate new ZPDs, gradually moving toward self-regulation through the gradual internalization of linguistic forms.

Results from the questionnaire indicate that human–computer interaction is the predominant form of mediation, reported by 60.9% of participants (n = 134). Interpersonal interaction accounts for 10.5% (n = 23), while 28.6% (n = 63) reported engaging in both forms.

Type of interaction	Percentage (n)
Human–computer interaction	60.9% (134)
Interpersonal interaction	10.5% (23)
Combined interaction	28.6% (63)

Table 1. Types of interactions creating ZPDs in Smartphone-Assisted English Language Learning
Source: created by the author.

Activities associated with human–computer interaction are diverse. The most frequent practices include video streaming (90%, n = 198), music streaming (84.55%, n = 186), translators (80.91%, n = 178), and search engines (70.91%, n = 156), followed by browsers (60.91%, n = 134), language-learning applications (57.27%, n = 126), bilingual dictionaries (55.45%, n = 122), educational social media pages (54.55%, n = 120), reading applications (45.91%, n = 101), and word processors (41.36%, n = 91).

In contrast, activities involving interpersonal interaction were reported less frequently. Participants indicated using instant messaging applications such as WhatsApp, Telegram, or WeChat (62.27%, n = 137), video calls (47.27%, n = 104), email (25.45%, n = 56), voice calls (19.09%, n = 42), and language exchange applications such as HelloTalk or Tandem (14.55%, n = 32). Only one respondent mentioned another platform, a Discord server dedicated to English learning (0.45%, n = 1).

The questionnaire also examined the characteristics of interpersonal interactions. Most learners reported engaging in such interactions occasionally (49.1%, n = 108), while 23.6% (n = 52) reported frequent participation and 27.3% (n = 60) reported never engaging in them. Of the 160 participants who reported engaging in interpersonal interaction at least occasionally, 140 answered the follow-up questions concerning synchronicity and communication mode. The percentages reported for synchronicity and communication mode are therefore based on n = 140. Communication was predominantly asynchronous or combined synchronous and asynchronous modes; interactions most often involved both written and audiovisual modes, or only written exchanges.

Dimension	Category	Percentage (n)
Frequency of interaction	Frequently	23.6% (52)
	Occasionally	49.1% (108)
	Never	27.3% (60)
Synchronicity	Asynchronous	36.4% (51)
	Both synchronous and asynchronous	51.4% (72)

	Synchronous	12.1% (17)
Communication mode	Audiovisual exchanges	8.6% (12)
	Written exchanges	32.1% (45)
	Both audiovisual and written	59.3% (83)

Table 2. Characteristics of interpersonal interactions in Smartphone-Assisted English Language Learning

Source: created by the author.

Overall, the questionnaire results indicate that Smartphone-Assisted English Language Learning (SPAELL) contexts primarily foster ZPDs through human–computer interaction, highlighting the central role of object-mediated semiotic activity. Although interpersonal mediation is present, it occurs less frequently and tends to be asynchronous and text-based rather than synchronous audiovisual interaction. From a sociocultural perspective, this pattern suggests that learners rely mainly on technological mediation to support self-regulation through the internalization of linguistic knowledge.

4.2 Qualitative Evidence from Interviews and Screen Recordings

Participants' accounts and smartphone interactions illustrate how digital environments mediate learning within the Zone of Proximal Development (ZPD) in informal English learning contexts. Across both interviews and screen recordings, learning activities frequently began with metacognitive processes of self-assessment, through which learners identified strengths and weaknesses and planned strategies targeting areas within their ZPDs.

One participant described focusing on listening after recognizing comprehension difficulties: “There was a time when I felt I really needed to improve my listening quickly... I couldn’t understand that much, depending on the language variety⁵” (I1⁶). Another participant reported a similar reflective process: “I see it as a challenge... we first have to make a plan, then do a self-analysis, see what I struggle with the most” (I3). In some cases, digital platforms supported this evaluation by providing

⁵ Excerpts from the interviews were translated from Portuguese into English and edited for readability.

⁶ I1, I2, I3, I4, and I5 refer to Interviewees 1, 2, 3, 4, and 5, respectively.

statistics or automated feedback. As one interviewee explained, “I can go back to a Duolingo lesson from the start... see my statistics, what I’m improving, what I got worse... so I can get a serious evaluation” (I5).

Interactions with other digital tools and online content also contributed to learning within the Zone of Proximal Development (ZPD) by providing structured tasks aligned with learners’ abilities. One participant described using a website with graded activities: “There’s audio. I love that site [News in Levels]. I can practice reading and listening” (I1). Similarly, chatbots integrated into messaging applications offered guided activities: “There were two contacts on WhatsApp... Chat Class and Chat English... it would start and give options like listening activities or lessons about the simple present” (I1). Writing tools also functioned as mediational resources. One participant reported using Grammarly while completing university assignments: “If I’m typing in Google Docs... Grammarly gives suggestions... I think these are good tools” (I2).

Screen recordings revealed similar patterns of mediation received through human–computer interaction. In some contexts, participants engaged with structured exercises that guided their performance. For example, participant 4 (P4) completed a reading task connecting questions and answers about a typical workday. The instruction (“Put the number of the correct answer into each space”) provided explicit guidance directing the learner toward language patterns slightly beyond her current competence.

In other contexts, learners interacted with authentic materials. Participant 3 (P3), for instance, read an article from an online magazine (P3SC1⁷). During this activity, the participant accessed a dictionary entry directly from the interface only once, suggesting overall comprehension while using lexical support to facilitate vocabulary development.

Across recordings, algorithmic mediation frequently shaped learning opportunities. Applications recommended personalized posts, videos, and exercises based on previous interactions. In one case, Participant 1 (P1) accessed a section of an app containing curated content generated from earlier engagement. Less frequently, human guidance influenced learning trajectories indirectly; for example, P4 received an email linking to a list of false cognates, illustrating how formal educational contexts can shape subsequent informal learning activities.

⁷ P3SC1 refers to “Participant 3 Screen recording 1”.

Once engaged with activities, participants generally appeared able to operate within their ZPDs. In a gamified exercise (P3SC2⁸), P3 correctly supplied the expected words in eight out of ten sentences. Similarly, P4 answered 80% of questions correctly in a structured reading activity. Such results suggest that the tasks required knowledge largely situated within the learners' ZPDs.

Participants also described processes of internalization when newly encountered language was applied across contexts. One interviewee recalled learning vocabulary through social media: "I saw a post about kitchen vocabulary... I see the cupboard and remember it... even if it was a recent encounter, I already internalized it" (I2). Another highlighted the role of error correction: "It's trial and error. If you make mistakes, you see where you went wrong and internalize it" (I2). Multimedia resources were likewise perceived as facilitating learning by linking visual and verbal information: "[Multimedia content] mediates learning... because of the image, you keep it in memory" (I5).

The recordings also revealed strategies supporting comprehension and production. Participants frequently used their first language as a scaffold. In one example (P2SR1⁹), a content creator asked in Portuguese, "Gosh, what does 'wish' mean?" before explaining the term in the same language. Target-language examples such as "*I wish I had more free time*" and "*Excuse me. I wish to speak to the manager, please*" reinforced these explanations. Grammar explanations were sometimes presented through explicit formulas, such as *wish + (that) + past simple*, combined with example sentences.

Additional mediational strategies included dictionary consultation, audiovisual transcripts, and visual feedback in gamified tasks. In one recording (P3SR2), a "Game over" screen displayed accuracy, speed, and total score, with incorrect answers highlighted for revision. Evidence of self-regulated learning also emerged during problem-solving. In one instance, P3 spent 41 seconds analyzing the sentence "*After the concert, there was a very long line waiting to use the lady's room*", making two attempts before successfully correcting the error.

When algorithmic mediation proved insufficient, participants sometimes sought interpersonal support. One interviewee described asking a classmate for help through WhatsApp: "If I can't solve it, I ask for help... like, this question here... why? I don't understand it well" (I1). Another reported collaborative learning through video calls while completing exercises in a language-learning application: "We join a Google Meet room and do the lessons together... we're ten people" (I5). Informal peer

⁸ P3SR1 refers to "Participant 3 Screen recording 2".

⁹ P2SR1 refers to "Participant 2 Screen recording 1".

groups formed within university contexts also functioned as collaborative learning spaces: “We have the college group... we’re always there clearing doubts and helping each other” (I4).

However, meaningful social interaction in digital environments appeared limited. Comment sections in online platforms rarely generated substantive exchanges; one example consisted only of a brief message (“*great post! thanks!*”). Although some participants experimented with language exchange platforms, these interactions were not always perceived as meaningful. One participant observed that exchanges with strangers often lacked shared interests and therefore felt less natural (I3). By contrast, interactions within existing social or academic networks (e.g., a project collaboration with an American student conducted through WhatsApp messaging) were considered more productive (I3).

Despite the advantages of smartphone-mediated resources, participants emphasized that digital tools do not replace face-to-face interaction. As one interviewee noted, “These resources don’t substitute [in-person interactions]... everything complements each other” (I1). Another similarly stated, “The smartphone helps a lot, but nothing replaces human contact” (I2).

Overall, the qualitative data suggest that smartphones provide significant mediational support for self-directed learning and the expansion of ZPDs, primarily through human–computer interaction. Nevertheless, opportunities for richer interpersonal scaffolding remain limited, suggesting that algorithmically mediated smartphone environments complement rather than replace in-person interaction in English language development.

4.3 Virtual Group Interactions

The triangulation of qualitative data from virtual group interactions, analyzed in relation to Zones of Proximal Development (ZPDs) created in Smartphone-Assisted English Language Learning (SPAELL) contexts, reinforces the predominance of human–computer interaction identified in other instruments. Participants’ messages focused less on interpersonal interaction within the group and more on external digital resources, such as online dictionaries and video platforms, indicating a preference for individual interaction with technological tools.

The following excerpt illustrates this pattern:

[05/04/22 21:16:42] I've been learning on my own.

[05/04/22 21:17:20] I have difficulty with writing.

[05/04/22 21:17:57] <https://dictionary.cambridge.org/pt/>

[05/04/22 21:18:34] I use it for vocabulary and it's really good.

[05/04/22 21:18:55] This is a great one.

[05/04/22 21:19:21] I'm gonna use it from now on.

[05/04/22 21:20:43] My first experience writing in English has been here

[05/04/22 21:20:49] A piece of advice too: listen to a youtuber teaching English, and watch TV series subtitled in English with the original audio.

[05/04/22 21:22:09] I'm doing this... it's been good, and I've been practicing my listening.

This exchange shows participants recommending external tools to support language learning. One participant reported difficulty with writing, leading another to suggest the Cambridge Dictionary as a vocabulary resource. A third participant acknowledged the recommendation (“I’m gonna use it from now on”), indicating recognition of a new learning affordance. Participants also encouraged the use of audiovisual resources, such as YouTube videos and subtitled series, to support listening practice.

Although the interaction involved the sharing of recommendations, the virtual environment was used mainly to circulate external resources rather than sustain peer scaffolding. The relatively small number of messages and the limited development of collaborative discussion suggest that interpersonal interaction remained minimal. This outcome reflects the broader pattern observed across the study: participants consistently favored human–computer interaction and receptive activities, while the productive, interpersonal interaction required in a group chat was precisely the kind of interaction they most avoided. Nevertheless, the participant who described the conversation as their “first experience writing in English” indicates that the group still created an informal space for written practice outside formal educational contexts.

This predominance of human–computer interaction is consistent with findings from other instruments in the study, which showed a preference for receptive activities (e.g., reading texts, consulting dictionaries, and watching videos) over interpersonal interaction. Consequently, while the virtual group had the potential to support ZPDs through collaborative mediation, limited interpersonal communication constrained opportunities for co-constructed learning. From a sociocultural perspective, the emergence of a collaborative ZPD typically requires a shared task and the presence of a more knowledgeable peer (Vygotsky, 1978); the absence of a defined common purpose, a moderator, and pre-existing social ties within the group likely inhibited sustained interaction.

In sum, the virtual group functioned primarily as a bridge connecting participants to external digital resources rather than as a space for sustained interpersonal interaction. Although learners identified and used affordances related to vocabulary, writing, and listening comprehension, these are largely mediated by human-computer interaction. As a result, the development of more complex ZPDs (i.e., typically supported by interpersonal interaction) remained limited in this context. This finding reaffirms the overall conclusion that smartphones, while affording rich opportunities for self-directed, algorithm-mediated learning, were not spontaneously used for the dense collaborative scaffolding necessary to expand ZPDs beyond human-computer interaction.

5. Discussion

This section interprets the findings in relation to the research question: *How do smartphones mediate English learning within the ZPD of Brazilian English teacher education students in informal contexts?* The analysis draws on the sociocultural framework of the ZPD (Vygotsky, 1978) and the methodological triangulation employed in this study (Dörnyei, 2007), which combined a questionnaire, semi-structured interviews, screen recordings, and interactions in a WhatsApp group. By concentrating exclusively on smartphones, this study responds to the need for device-specific investigations within the field, thereby contributing to the emerging area of Smartphone-Assisted English Language Learning (SPAELL). At the same time, because smartphones constitute one class of mobile devices, the results also enrich the broader research agenda of Mobile-Assisted Language Learning (MALL) and, by extension, Computer-Assisted Language Learning (CALL), offering insights that can be contrasted with studies involving other mobile and computer-based technologies.

The findings indicate that smartphone-mediated ZPDs emerge primarily in two forms. The first involves algorithmic mediation through cultural artifacts (Cole, 1998) in human-computer interactions, such as automated feedback from language-learning applications and digital platforms. The second involves interpersonal interaction through communication with others via smartphones. In some cases, learners first engaged with algorithmically mediated activities and later sought interpersonal support when technological mediation proved insufficient.

The data suggest that participants may engage in cognitive self-assessment when interacting with the affordances (Gibson, 1986; van Lier, 2000) of these environments. Learners evaluate their Zones of Actual Development (ZADs) through reflection or through diagnostic tools embedded in digital platforms that assess linguistic performance (e.g., Mengjie et al., 2021). Based on this evaluation, they

select activities aligned with their competence. Evidence from interviews and screen recordings suggests that these choices generally corresponded to learners' ZADs, allowing them to operate within ZPDs.

Triangulated data indicate that human–computer interaction with algorithmic mediation constitutes the most prevalent form of ZPD in the sample. This pattern aligns with previous studies if interpreted through the ZPD framework (Hidayati & Endayani, 2019; Huzairin et al., 2020; Jurkovič, 2019; Mutiaraningrum & Nugroho, 2021; Luo & Watts, 2022). Such interactions provide semiotic mediation that appears to support the expansion of learners' ZADs, particularly in receptive skills such as reading and listening.

Human–computer interaction operates in at least two complementary ways. First, it can stimulate metacognitive engagement, as learners reflect on explanations or suggestions provided by digital tools. Second, it may provide binary feedback (correct/incorrect), which, although cognitively simpler, can still support incremental development within learners' ZADs and ZPDs (Vygotsky, 1978; Lantolf, 2000). Lexical development appears to benefit especially when these tools combine multimodal input, including written, oral, and visual elements.

Human–computer interaction may also function as a mechanism for verifying intrapersonal mediation (Figueiredo, 2019). After producing language using semiotic resources already internalized in their ZADs, participants frequently consulted digital tools to confirm or revise their output. This process allowed learners to validate their production and encounter alternative linguistic forms, potentially expanding both their ZADs and ZPDs.

In some cases, interaction occurred without deliberate learner initiation. Algorithmically curated content introduced new learning opportunities that learners subsequently engaged with. When such recommendations aligned with learners' ZPDs, they tended to generate sustained engagement; when they exceeded learners' competence levels, they were less likely to support the internalization (Vygotsky, 1978) of new knowledge.

When human-computer interaction proved insufficient, learners sometimes turned to interpersonal interaction for support. Compared with the relatively rigid feedback of digital systems, interpersonal mediation offers greater flexibility and responsiveness. Content creators, for example, often combine learners' first language with the target language to facilitate comprehension, a strategy

observed in previous research (Jurkovič, 2019; Sierocka et al., 2019; Huzairin et al., 2020; Putrawan & Riadi, 2020). While this approach may support understanding, it can also reduce opportunities for direct engagement with target-language affordances.

Applications designed for language exchange provide opportunities for interpersonal interaction but may face practical limitations, such as difficulties in finding compatible interlocutors. Social media platforms may enable more meaningful interaction by connecting individuals who already share social relationships, supporting the emergence of communities of practice (Lave & Wenger, 1991). In this study, for instance, a virtual group formed by university peers functioned as an informal learning environment connected to formal coursework. Such cases illustrate how smartphone-mediated environments can link formal and informal learning contexts, supporting observations from previous research (Hidayati & Endayani, 2019; Luo & Watts, 2022).

Despite this potential, interpersonal interaction occurred far less frequently than human–computer interaction. Participants tended to interact asynchronously through written messages rather than synchronously through audiovisual communication, a pattern also observed in other contexts (Wrigglesworth & Harvor, 2018; Sierocka et al., 2019; Huzairin et al., 2020; Putrawan & Riadi, 2020). Factors such as personality traits, technological constraints, and apprehension about interacting with unfamiliar interlocutors may contribute to this tendency, suggesting that offline sociocultural insecurities can extend into digital learning environments.

Two broader observations emerge from this analysis. First, participants primarily engaged in Smartphone-Assisted English Language Learning (SPAELL) in informal contexts to develop lexical knowledge and receptive skills, particularly reading and listening (Hidayati & Endayani, 2019; Varga et al., 2018; Jurkovič, 2019; Sierocka et al., 2019; Huzairin et al., 2020; Luo & Watts, 2022) through human-computer interaction, while opportunities for productive and interactive language use through interpersonal interaction remained comparatively underexplored (Godwin-Jones, 2017). Second, these findings highlight the need for pedagogical initiatives in Brazilian public universities that encourage learners to engage with technological affordances supporting productive and interactive language use. Given the ubiquity of smartphones in students' daily lives, integrating these devices into pedagogical strategies may help foster interpersonal interaction and support learning within more complex Zones of Proximal Development (ZPDs) in SPAELL in informal contexts.

By delimiting the analysis to smartphones, the study avoids the terminological and methodological ‘mixing of apples and oranges’ (Godwin-Jones, 2017, p. 5) that has often characterized mobile learning research, thereby providing a clearer portrait of SPAELL. At the same time, because smartphones are the most widely used mobile device in Brazil, these findings contribute to SPAELL research in Latin America, a region still underrepresented in the global literature (Persson & Nouri, 2018), and offer evidence that can inform both MALL and CALL scholars about the unique affordances and constraints of a device that has become, for many, a ‘digital appendage’ (Godwin-Jones, 2017, p. 4).

6. Conclusion

This study examined how smartphones mediate English learning within the ZPDs of Brazilian English teacher education students in informal contexts. Using a mixed-methods design that combined a questionnaire, interviews, smartphone screen recordings, and WhatsApp interactions, the study explored how digital tools accessed through smartphones support learning beyond the classroom.

The findings indicate that smartphone-mediated learning occurs predominantly through human–computer interaction. Learners frequently engage with digital resources such as streaming platforms, translators, search engines, and language-learning applications, which provide algorithmic feedback, multimodal input, and opportunities for self-regulated learning. These interactions appear particularly conducive to the development of receptive skills, especially reading, listening, and vocabulary.

Interpersonal interaction through smartphones occurs less frequently and is typically asynchronous and text-based. Learners therefore tend to rely mainly on technological mediation, seeking interpersonal support when digital tools prove insufficient. While smartphones provide valuable affordances for self-directed learning, they do not fully replace the developmental benefits of direct human interaction.

Overall, the results highlight the potential for pedagogical initiatives that integrate Smartphone-Assisted English Language Learning (SPAELL) practices with activities promoting productive and interpersonal language use. Such approaches may help learners engage in more complex forms of mediation and expand opportunities for learning within their ZPDs. Future research could design and evaluate pedagogical strategies that explicitly guide learners toward using

smartphones for interpersonal and productive language tasks, fostering ZPDs beyond the predominantly receptive practices through human-computer interaction observed in this study.

Referências

BORGES, R. A.; GARCIA-FILICE, R. C. A língua inglesa no Programa Ciência sem Fronteiras: paradoxos na política de internacionalização. *Interfaces Brasil/Canadá*, v. 16, n. 1, p. 72–101, 2016. DOI: <https://doi.org/10.15210/interfaces.v16i1.7516>.

BRAUN, V.; CLARKE, V. *Successful qualitative research: a practical guide for beginners*. London: SAGE, 2013.

CAWS, C.; HAMEL, M.-J. (ed.). *Language-learner computer interactions: theory, methodology and CALL applications*. Amsterdam: John Benjamins, 2016.

COLE, M. *Cultural psychology: a once and future discipline*. Cambridge, MA: Harvard University Press, 1998.

DÖRNYEI, Z. *Research methods in applied linguistics: quantitative, qualitative, and mixed methodologies*. Oxford: Oxford University Press, 2007.

FIGUEIREDO, F. J. Q. *Vygotsky: a interação no ensino/aprendizagem de línguas*. 1. ed. São Paulo: Parábola, 2019.

FÓRUM NACIONAL DE PRÓ-REITORES DE ASSUNTOS COMUNITÁRIOS E ESTUDANTIS (FONAPRACE). *V Pesquisa Nacional de Perfil Socioeconômico e Cultural dos(as) graduandos(as) das IFES – 2018*. Brasília: FONAPRACE, 2019. Disponível em: <https://www.andifes.org.br/wp-content/uploads/2021/07/Clique-aqui-para-acessar-o-arquivo-completo.-1.pdf>. Acesso em: 11 mar. 2026.

GIBSON, J. J. *The ecological approach to visual perception*. Hillsdale: Lawrence Erlbaum, 1986.

GODWIN-JONES, R. Smartphones and language learning. *Language Learning & Technology*, v. 21, n. 2, p. 3–17, 2017. DOI: <https://doi.org/10.64152/10125/44607>.

HUZAIRIN, H.; PUTRAWAN, G. E.; RIADI, B. Technology and language learning: English as a Foreign Language learners' use of smartphones for online informal learning in Indonesia. *Texto Livre: Linguagem e Tecnologia*, v. 13, n. 3, p. 103–120, 2020.

JURKOVIČ, V. Online informal learning of English through smartphones in Slovenia. *System*, v. 80, p. 27–37, 2019. DOI: <https://doi.org/10.1016/j.system.2018.10.007>.

LAVE, J.; WENGER, E. *Situated learning: legitimate peripheral participation*. Cambridge: Cambridge University Press, 1991.

LEIS, A.; TOHEI, A.; COOKE, S. Smartphone Assisted Language Learning and autonomy. *International Journal of Computer-Assisted Language Learning and Teaching*, v. 5, n. 3, p. 75-88, 2015.

LUO, Y.; WATTS, M. Exploration of university students' lived experiences of using smartphones for English language learning. *Computer Assisted Language Learning*, 2022. DOI: <https://doi.org/10.1080/09588221.2022.2052904>.

MARANDINO, M. Faz sentido ainda propor a separação entre os termos educação formal, não formal e informal? *Ciência & Educação*, v. 23, p. 811–816, 2017. DOI: <https://doi.org/10.1590/1516-731320170030001>.

MENGJIE, L.; NOORDIN, N.; LILLIATI, I.; RAHIM, N. A.; ZAREMOHZZABIEH, Z. The role of smartphone applications as English learning tools among Chinese university students. *Turkish Journal of Computer and Mathematics Education (TURCOMAT)*, v. 12, p. 385–398, 2021.

MUTIARANINGRUM, I.; NUGROHO, A. Mobile assisted language learning application in higher vocational education in Indonesia. *Journal of Engineering Education Society*, v. 6, n. 1, 2021. DOI: <https://doi.org/10.21070/jees.v6i1.793>.

NÚCLEO DE INFORMAÇÃO E COORDENAÇÃO DO PONTO BR (NIC.br). *Pesquisa sobre o uso das tecnologias de informação e comunicação nos domicílios brasileiros: pesquisa TIC Domicílios*, ano 2022. São Paulo: NIC.br, 2023. Disponível em: <https://cetic.br/pt/arquivos/domicilios/2022/domicilios/>. Acesso em: 11 mar. 2026.

PERSSON, V.; NOURI, J. A systematic review of second language learning with mobile technologies. *International Journal of Emerging Technologies in Learning (IJET)*, v. 13, 2018. DOI: <https://doi.org/10.3991/ijet.v13i02.8094>.

PINHEIRO, D. C.; PEREIRA, R. D.; XAVIER, W. S. Impactos das cotas no ensino superior: um balanço do desempenho dos cotistas nas universidades estaduais. *Revista Brasileira de Educação*, v. 26, e260020, 2021. DOI: <https://doi.org/10.1590/S1413-24782021260020>.

PUTRAWAN, G.; RIADI, B. English as a foreign language (EFL) learners' predominant language use for online informal learning activities through smartphones in Indonesian context. *Universal Journal of Educational Research*, v. 8, n. 2, p. 695–699, 2020. DOI: <https://doi.org/10.13189/ujer.2020.080243>.

QIN, L.; REN, W. Investigating affordance in technology-enriched language learning environment through exploring students' perezhivanija. *Chinese Journal of Applied Linguistics*, v. 44, n. 2, p. 187–202, 2021.

ROSELL-AGUILAR, F. State of the app: A taxonomy and framework for evaluating language learning mobile applications. *CALICO Journal*, v. 34, n. 2, p. 243–258, 2017. DOI: <https://doi.org/10.1558/cj.27623>.

ŞAD, S.; ÖZER, N.; YAKAR, U.; ÖZTÜRK, F. Mobile or hostile? Using smartphones in learning English as a foreign language. *Computer Assisted Language Learning*, v. 35, n. 5–6, p. 1031–1057, 2022. DOI: <https://doi.org/10.1080/09588221.2020.1770292>.

SIEROCKA, H.; JURKOVIČ, V.; VARGA, M. The role of smartphones for online language use in the context of Polish and Croatian students of different disciplines. *Studies in Logic, Grammar and Rhetoric*, v. 58, n. 1, p. 173–193, 2019.

VAN LIER, L. From input to affordance: social-interactive learning from an ecological perspective. In: LANTOLF, J. P. *Sociocultural theory and second language learning*. Oxford: Oxford University Press, 2000. p. 155–177.

VARGA, M.; JURKOVIČ, V.; SIEROCKA, H. English communicative competence and predominant language for online use through smartphones in Croatia as compared to Slovenia. *ExELL*, v. 6, n. 2, p. 130–162, 2018. DOI: <https://doi.org/10.2478/exell-2020-0002>.

VYGOTSKY, L. S. *Mind in society: the development of higher psychological processes*. Edited by M. Cole et al. Cambridge, MA: Harvard University Press, 1978.

WRIGGLESWORTH, J.; HARVOR, F. Making their own landscape: smartphones and student designed language learning environments. *Computer Assisted Language Learning*, v. 31, n. 4, p. 437–458, 2018. DOI: <https://doi.org/10.1080/09588221.2017.1412986>.

Data de submissão: 16/03/2026. Data de aprovação: 08/06/2026.