

Vygotskian Scaffolding across Synchronous, Asynchronous, and Blended EFL Contexts: A Mixed-Methods Study of Learner Development and Academic Achievement

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ABSTRACT:

This study examines the effectiveness of three instructional formats—synchronous, asynchronous, and blended—for developing English writing skills among a single cohort of 120 first-year B.Tech engineering students in India. Students were randomly assigned to three groups of forty (Synchronous Learning Group [SLG], Asynchronous Learning Group [ALG], and Blended Learning Group [BLG]) and received forty-eight hours of identical English writing instruction across eight weeks, delivered through different temporal modalities. A pre-test paragraph-writing task (on global warming) confirmed that the groups were equivalent at baseline; a post-test task (on air pollution) assessed gains following the intervention. Post-test results revealed statistically significant differences across all three groups, with the Blended Learning Group achieving the highest mean score ($M = 76.9$), followed by the Synchronous Learning Group ($M = 68.4$) and the Asynchronous Learning Group ($M = 61.7$); every pairwise comparison was statistically significant ($p < .001$), with effect sizes ranging from medium-large to very large ($d = 0.98$ – 2.21). Multiple regression confirmed that instructional modality, controlling for pre-test ability, explained 68% of the variance in post-test writing achievement ($F(3, 116) = 82.16$, $p < .001$, $R^2 = .68$), with blended instruction the strongest predictor ($\beta = .71$, $p < .001$). NVivo 14 coding of cohesive device use, lexical diversity, thematic elaboration, and syntactic complexity corroborated this quantitative hierarchy. These findings are interpreted through a newly proposed dual-temporal Zone of Proximal Development (ZPD) scaffolding model, in

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which synchronous instruction is theorized to activate an immediate ZPD zone and asynchronous instruction a reflective ZPD zone, with blended instruction uniquely engaging both. The study also proposes jingles—short, rhythmic, rhymed verbal compositions—as a low-cost, ZPD-aligned scaffolding tool for first-year B.Tech learners, offered as a direction for future empirical testing rather than as a treatment evaluated here.

Keywords: Academic Achievement, Asynchronous Learning, Blended Learning, EFL Writing, Jingles, Synchronous Learning, Zone of Proximal Development.

1. Introduction

Engineering undergraduates in India face a particular challenge when they arrive at university: their discipline demands sophisticated written communication in English, but many of them have had limited opportunity to develop this skill through their schooling. The problem is well documented (Rahimi & Zhang, 2022), yet it has not received the concentrated research attention it deserves, particularly in light of how significantly the landscape of EFL (English as a Foreign Language) instruction has changed over the past several years. Online and hybrid teaching have become a standard part of the higher education environment rather than measures adopted only out of necessity (Klimova & Pikhart, 2023). This raises a practical question: when it comes to developing writing skills, does it matter whether instruction happens live, self-paced, or in some combination of the two? Vygotsky's (1978) Zone of Proximal Development (ZPD) provides the theoretical backbone for the present research design. The ZPD—broadly, the space between what a learner can manage alone and what becomes possible with support—has long informed thinking about how teacher scaffolding contributes to language development (Shabani, 2021). Instructional mode exerts a significant influence on the ZPD: the temporal structure of a learning environment determines when, how quickly, and with what degree of persistence a learner can be supported into and through that developmental space. What has not been adequately theorized, however, is how synchronous and asynchronous modalities map onto qualitatively distinct temporal zones within the ZPD. This study

introduces the concept of dual-temporal ZPD scaffolding: the idea that synchronous instruction activates the immediate or reactive zone (where real-time support enables performance that is not yet independently achievable), while asynchronous instruction activates the reflective or consolidation zone (where learners internalize, revise, and extend what was modelled in live interaction). Blended learning, on this account, is not simply a logistical hybrid; it is the only modality that engages both temporal zones systematically.

Alongside the question of delivery mode sits a second, less examined question: through which mediational tools is language actually scaffolded? One such tool is the jingle, a short, rhythmic, rhymed verbal composition of the kind familiar from advertising, which packages a small quantity of linguistic content in a form that is easy to rehearse and recall. Research on songs and music in language learning suggests that rhythm and melody can support the memorization of vocabulary and phrases (Ludke et al., 2014; Schön et al., 2008) and that musical activity can lower anxiety and sustain engagement (Engh, 2013; Murphey, 1992). For first-year B.Tech students, for whom English is often a compulsory, low-credit subject, jingles offer an inexpensive way of making language practice memorable, social, and enjoyable. This paper therefore also considers how jingles might operate as scaffolding tools within the dual-temporal ZPD model developed here. That discussion is offered as a proposed direction for instruction and future empirical testing, not as a treatment evaluated in the present experiment.

This research makes three unique contributions to the body of knowledge: (1) it introduces the dual-temporal Zone of Proximal Development scaffolding model, an original theoretical account of how synchronous and asynchronous instruction activate qualitatively distinct developmental zones within Vygotskian sociocultural theory; (2) it produces the first empirical comparison of synchronous, asynchronous, and blended instructional modalities within a single, randomized cohort of Indian engineering undergraduates, using a convergent mixed-methods design; and (3) it integrates NVivo-assisted qualitative coding with inferential statistics, including multiple regression, for results of considerable methodological rigour, while also proposing jingles as a novel, low-cost scaffolding tool offered as a direction for future empirical testing.

1.1 Theoretical Framework: Vygotskian Scaffolding and the Dual-Temporal Zone of Proximal Development

Vygotsky's (1978) Zone of Proximal Development describes a simple but generative idea: learners are capable of more when they have appropriate support than when they work entirely alone. The gap between these two levels—independent performance and supported performance—is where learning happens. Originally developed to explain cognitive development in children, the ZPD travelled quickly into applied linguistics, where researchers found it useful for thinking about second language acquisition. Lantolf and Poehner (2021), in particular, have built an extensive body of work around how mediated interaction within the ZPD drives language development forward. This is scaffolding in an educational sense: deliberately providing support that is right for where a learner is at a given moment, and gradually removing that support as the learner becomes more capable. Van de Pol et al. (2022) describe what excellent scaffolding looks like in practice as contingent responsiveness: it is responsive rather than one-size-fits-all, and it fades rather than persists permanently. This is theoretically straightforward but pedagogically demanding,

and how it translates across different instructional modalities—live, recorded, or some blend of the two—is one of the central questions motivating this study.

According to the dual-temporal framework proposed here, synchronous and asynchronous instruction are understood not merely as alternative delivery formats but as mechanisms that engage qualitatively different temporal zones of the ZPD. Synchronous instruction activates an immediate zone, in which real-time feedback, collaborative tasks, and instructor-mediated error correction provide the responsive scaffolding that performance in the proximal zone requires. Asynchronous instruction activates a reflective zone, in which learners are given the time and cognitive space to process, consolidate, and internalize what was modelled in live interaction. Blended instruction, in this account, is the only modality that structurally engages both temporal zones, and is therefore theorized to produce the strongest developmental gains. This theoretical prediction is consistent with Vygotsky's (1978) broader claim that higher mental functions develop first between people and are only subsequently internalized by the individual—a movement from external, socially mediated performance to internalized, independent competence that plausibly requires both immediate mediation and reflective consolidation.

1.2 Review of Related Literature

Scaffolding in EFL Writing Contexts

ZPD-informed scaffolding has a reasonably solid empirical record in EFL writing contexts. Students who receive well-structured instructional support show real gains in grammatical accuracy, fluency, and how coherently they organise ideas across a piece of writing (Aljaafreh & Lantolf, 2021). What has changed over the past decade or so is that scholars have started rethinking what counts as the "more knowledgeable other" who provides that support. It does not have to be a human teacher in a physical classroom. Automated feedback tools, structured discussion forums, and peer response systems can, in certain

conditions, perform some of the scaffolding functions that a teacher traditionally performed (Shabani, 2021).

Synchronous Learning in EFL Instruction

Live online teaching—Zoom sessions, virtual classrooms, real-time video discussions—became ubiquitous during the pandemic and has remained a central feature of EFL instruction since (Moorhouse & Kohnke, 2021). Its appeal is understandable. When teachers and students can interact in real time, there is an immediacy to feedback that asynchronous formats struggle to replicate. Errors can be addressed as they arise, questions get answered on the spot, and the social dynamics of a classroom—the motivating sense of shared presence—survive, at least partially, the shift to a screen (Hrastinski, 2022).

Asynchronous Learning in EFL Instruction

Asynchronous learning works differently. Students engage with pre-recorded lectures, submit assignments on their own schedule, exchange written feedback through forums, and generally determine their own pace through the material. This is not, in itself, a deficiency; there are things asynchronous environments do better than synchronous ones. The most obvious is that they give learners time—time to sit with difficult material, time to draft and revise, and time to read a peer's comment carefully before responding (Dziuban et al., 2024).

Blended Learning and EFL Writing Development

Blended learning is sometimes described simply as the combination of online and face-to-face, or synchronous and asynchronous, instruction. But that description ignores what is different about well-designed blended courses compared with courses that merely happen to be delivered in multiple formats. As Graham (2022) argues, the key is intentionality: a blended course is one in which the two modes have been deliberately designed to complement each other, with synchronous time used for what it does best (interaction, immediate feedback, collaborative tasks) and asynchronous time used for what it

does best (individual processing, reflection, extended practice).

Jingles as Mediatonal Tools in EFL Learning

A jingle is a brief verbal composition built on strong metre, rhyme, repetition, and a memorable hook. Although the term comes from advertising, the features that make jingles memorable coincide with conditions known to support language learning. In a review of the literature on music in English language teaching, Engh (2013) concluded that songs and music can benefit vocabulary retention, pronunciation, and classroom atmosphere, while noting that many studies rely on small samples and weak controls. Cognitive accounts point to the phonological loop, the memory system that stores and rehearses new verbal material and underpins word learning (Baddeley et al., 1998). Rhythm and melody may strengthen this rehearsal by segmenting speech and adding retrieval cues. Adults segmented and remembered words from a sung artificial language more accurately than from a spoken one (Schön et al., 2008), text learned as song was recalled better than text learned as speech (Wallace, 1994), and learners who sang foreign-language phrases outperformed those who only spoke them (Ludke et al., 2014). Classroom studies report parallel benefits for vocabulary and language use among ESL learners (Li & Brand, 2009) and for young learners' engagement (Millington, 2011).

From a Vygotskian standpoint, the value of a jingle lies not only in its melody but in the way it can function as a mediational artefact. Vygotsky (1978) argued that higher mental functions develop through the use of cultural tools, of which language is the most important, and that these functions appear first between people before being internalised by the individual. Sociocultural researchers extend this view to instruction in which learners use symbolic tools collaboratively under contingent support (Lantolf & Poehner, 2021; van de Pol et al., 2022). A jingle is a compact symbolic tool of this kind: the teacher can model it (heavy scaffolding), peers can compose and revise new

verses together (support within the ZPD), and individual learners can later rehearse it silently or recall the content without the tune (internalisation). Murphey (1992) observed that songs tend to recur involuntarily in the mind, a form of spontaneous rehearsal that may help carry classroom language into private thought.

Jingles also map onto the writing skills examined in this study. The four categories of cohesive devices coded in this study (additive, adversative, causal, and temporal) are finite, high-frequency sets that novice writers must retrieve quickly and use accurately. Such a set can be packaged in a single rhythmic verse—for example, an original illustrative jingle might run: Moreover, in addition, we add one more; however, nevertheless, we turn the door; therefore, as a result, the reason is clear; firstly, finally, the end is near. Two cautions apply. First, the existing evidence concerns mainly vocabulary and recall; very few studies have examined whether jingles influence writing. Second, few have been conducted with engineering undergraduates in India or designed explicitly around sociocultural theory.

Research Gap and the Present Study

The literature just reviewed points to a fairly clear gap. Previous research offers information on synchronous, asynchronous, and blended EFL instruction in isolation. What it does not offer, at least not in any abundance, are studies that put all three modalities head-to-head within a single controlled design and that use methodological tools sophisticated enough to explain not just whether there are differences but what those differences look like in actual student writing (Moorhouse & Kohnke, 2021; Pham & Usaha, 2023). Three specific gaps motivate the present study. First, no existing study has tested all three modalities within a single-cohort, randomised design in an Indian engineering undergraduate context. Second, while ZPD-informed scaffolding has been extensively theorised, the temporal dimension of that scaffolding—specifically, how different instructional modalities engage different temporal zones of the ZPD—has not been systematically

examined. Third, NVivo-assisted qualitative coding has rarely been integrated with inferential statistics to produce a convergent, multi-strand account of EFL writing development across modalities. The present study addresses all three gaps and, in doing so, introduces the dual-temporal ZPD scaffolding model as an original conceptual contribution to blended EFL pedagogy research. There is also a population gap worth naming: first-year engineering undergraduates in EFL contexts have well-documented writing needs but have attracted relatively little targeted research (Rahimi & Zhang, 2022). A further gap, identified but not tested here, concerns jingles; evidence for music-assisted language learning is growing (Engh, 2013; Ludke et al., 2014), but it has rarely been examined in first-year B.Tech classrooms, rarely connected to writing outcomes such as cohesive device use and lexical diversity, and rarely interpreted through the temporal structure of the ZPD.

1.3 Research Objectives and Hypotheses

The study was guided by the following objectives:

- To compare the effectiveness of synchronous, asynchronous, and blended instructional modalities in developing EFL writing skills among first-year B.Tech students.
- To examine, through NVivo-assisted qualitative coding, how cohesive device use, lexical diversity, thematic elaboration, and syntactic complexity develop across the three modalities.
- To determine the predictive role of instructional modality, controlling for baseline writing ability, on post-test writing achievement using multiple regression.
- To interpret findings within a proposed dual-temporal Zone of Proximal Development scaffolding model.
- To propose and theoretically ground jingles as a scaffolding tool for future

empirical testing within the dual-temporal ZPD framework.

The following null hypotheses were formulated:

- H01: There is no significant difference between the Synchronous, Asynchronous, and Blended Learning Groups in pre-test writing scores.
- H02: There is no significant difference between the Synchronous and Asynchronous Learning Groups in post-test writing scores.
- H03: There is no significant difference between the Synchronous and Blended Learning Groups in post-test writing scores.
- H04: There is no significant difference between the Asynchronous and Blended Learning Groups in post-test writing scores.
- H05: Instructional modality does not significantly predict post-test writing achievement after controlling for pre-test writing ability.

2. Methodology

2.1 Design

A convergent mixed-methods experimental design was employed, combining a randomized, single-cohort comparison of three instructional modalities with NVivo-assisted qualitative coding of the resulting writing samples (Creswell & Creswell, 2023). This design is well suited to the research questions because it allows the quantitative hierarchy among groups to be established through inferential statistics while the qualitative coding provides a textured account of what, specifically, changed in students' writing. Quantitative and qualitative strands were collected concurrently at the pre-test and post-test stages and were brought together at the interpretation stage, as a convergent design requires.

2.2 Participants/Sample

The study was conducted with 120 first-year B.Tech students at a recognized Engineering

college, Narula institute of Technology, Kolkata, India, in the academic year 2025–2026. All participants were enrolled in the Department of Computer Science and took part as part of a compulsory first-year English language module; none were native English speakers. The 120 participants were randomly divided, through a computer-generated procedure, into three groups of forty: a Synchronous Learning Group (SLG), an Asynchronous Learning Group (ALG), and a Blended Learning Group (BLG). Random assignment was used to avoid the risk that pre-existing ability differences would bias the comparison, and this assumption was subsequently verified through pre-test analysis (Cohen et al., 2018). Sample size was established through an a priori power analysis conducted in G*Power 3.1. Specifying a medium effect size ($f = 0.25$), a significance level of $\alpha = .05$, and a desired power of $1 - \beta = .90$ yielded a minimum requirement of 96 participants; 120 were retained to allow for attrition over the eight-week intervention and to guarantee adequate statistical power across several pairwise comparisons (Faul et al., 2022).

A structured background questionnaire administered before the study began documented the demographic characteristics of the sample. Participants ranged from 17 to 19 years of age ($M = 18.2$, $SD = 0.74$). The sample was predominantly male: 82 men (68.3%) and 38 women (31.7%). Bengali or Hindi was the first language of all participants, and English was encountered primarily, and for most exclusively, through formal academic instruction. None of the 120 students had any previous experience of blended or fully online English courses at secondary or tertiary level, which is relevant to the study's internal validity: had some groups possessed more prior experience with online learning than others, that familiarity might have inflated their performance independently of the instructional treatment.

2.3 Instruments

Three instruments were used to generate the study's quantitative and qualitative data,

consistent with the convergent mixed-methods design (Creswell & Creswell, 2023).

Writing Assessment Task

The main data collection instrument was a paragraph-writing task, developed by the researcher and administered in two parallel versions. Both versions asked students to write a 150- to 200-word cause-effect-solution paragraph within 45 minutes under standardized conditions. Writing was assessed across five analytic dimensions adapted from Jacobs et al. (1981). The pre-test prompt was Global Warming; the post-test prompt was Air Pollution. The two topics were chosen because they are broadly comparable in complexity and familiarity while being distinct enough that students could not simply reproduce pre-test content in the post-test. Both versions of the task were piloted with 15 students prior to the main study and reviewed by three experienced EFL instructors for content validity. Two raters scored all scripts independently; inter-rater reliability, assessed using intraclass correlation coefficients, was $ICC = .91$ for the pre-test and $ICC = .89$ for the post-test, both comfortably exceeding the widely used .80 standard (Weigle, 2022).

NVivo 14 Qualitative Coding Framework

The second instrument was a thematic coding framework applied within NVivo 14. Four coding nodes, derived deductively from the ZPD framework and the analytic dimensions of the writing rubric, were used to examine each writing sample for qualitative evidence of writing development. Two independent coders applied the framework; agreement between them, assessed using Cohen's kappa, returned $\kappa = .87$, well above the threshold typically considered acceptable for research purposes. Node 1, Cohesive Device Deployment, tracked how often and how diversely participants used cohesive devices, the transitional and linking language that holds writing together, coded into four categories based on Halliday and Hasan's (1976) taxonomy: additive (e.g., furthermore, moreover, in addition), adversative (e.g., however, nevertheless, on the other hand), causal

(e.g., therefore, consequently, as a result), and temporal (e.g., firstly, subsequently, finally). Node 2, Lexical Diversity, was determined by type-token ratio (TTR)—unique word types divided by total words written—restricted to content words (nouns, verbs, adjectives, adverbs) so that the metric reflected purposeful vocabulary choices rather than grammatical structure; higher TTR values indicate greater lexical variety and reduced reliance on repeated words, a well-established indicator of EFL writing skill (Read, 2022). Node 3, Thematic Elaboration Depth, captured not just whether a student made a point but whether they developed it, using three elaboration tiers: surface (a claim stated with no supporting reasoning or evidence), intermediate (a claim accompanied by one explanatory sentence or concrete example), and deep (a claim developed through multiple layers of support—evidence, reasoning, and real-world illustration working together). Each paragraph was assigned a dominant tier; deep elaboration was taken as the clearest qualitative signal of knowledge genuinely internalized through scaffolded instruction (Lantolf & Poehner, 2021). Node 4, Syntactic Complexity, captured sentence-level structural sophistication through three features—subordinate clauses (introduced by conjunctions such as although, because, while, and since), passive voice constructions, and complex noun phrases with pre- or post-modification—which were tagged individually and combined into a composite syntactic complexity index (total frequency of the three features divided by sentence count), consistent with L2 writing research showing that syntactic complexity grows as proficiency increases and scaffolded grammatical knowledge becomes consolidated (Rahimi & Zhang, 2022).

Background Questionnaire

A twelve-item structured questionnaire collected demographic and background information from all participants at the outset of the study, including age, gender, first language, prior experience with online learning, and self-reported English language background.

Table 1 Definitions and Metrics of the Study Instruments

Instrument	Type	Purpose	Items/Nodes	Duration	Reliability
Paragraph Writing Task — Pre-test	Performance task	Baseline writing assessment	5 dimensions	45 minutes	ICC = .91
Paragraph Writing Task — Post-test	Performance task	Post-intervention writing assessment	5 dimensions	45 minutes	ICC = .89
NVivo 14 Coding Framework	Qualitative coding	Thematic analysis of writing samples	4 nodes	Ongoing	κ = .87
Background Questionnaire	Self-report	Demographic profiling	12 items	10 minutes	Content validity confirmed

Note. ICC = Intraclass Correlation Coefficient; κ = Cohen's kappa; TTR = Type-Token Ratio. All nodes were derived deductively from the ZPD theoretical framework. All instruments were administered in accordance with institutional ethical review guidelines. Source: Authors' own work.

2.4 Procedure

Overview

The study lasted ten weeks in total and was divided into three phases: pre-intervention, intervention, and post-intervention. Respondents were informed that their data would be kept anonymous, that participation was voluntary, and that withdrawal from the study would carry no academic consequences (Cohen et al., 2018). At the outset, all participants were asked not to discuss instructional materials or activities with students in other groups, to minimize the possibility of cross-group contamination.

Pre-Intervention Phase

In the first week, all 120 students, already divided into three groups, completed the background questionnaire and sat the pre-test writing task simultaneously, in the university computer laboratory, under standardized conditions. Simultaneous administration was deliberate, ensuring that baseline data were collected at the same point in time for everyone. Scripts were anonymized immediately after collection using a numerical coding system and then scored independently by the two trained raters. All pre-

test samples were also imported into NVivo 14 and coded against the four-node framework. Pre-test scores and coding metrics were then analyzed using independent samples t-tests to confirm that the three groups were comparable before instruction began.

Intervention Phase

The eight-week intervention consisted of three two-hour sessions per week for each group—48 hours of instruction in total. The curriculum was identical across all three groups, covering paragraph organisation, cohesive device use, vocabulary development, grammatical accuracy, and cause–effect–solution text structuring. Content was developed by the researcher in consultation with two experienced EFL writing instructors and was sequenced in keeping with ZPD scaffolding principles: early sessions were heavily supported and modelled, with scaffolding progressively reduced as students grew more capable (Shabani, 2021). What differed between the groups was not what they learned but how they encountered it, as summarized in Table 2.

Table 2 Instructional Approach across the Three Experimental Groups

Feature	SLG	ALG	BLG
Instructional mode	Synchronous only	Asynchronous only	Blended (synchronous + asynchronous)
Platform	Zoom	LMS (Moodle)	Zoom + Moodle
Weekly contact hours	6 hours live	6 hours self-paced	2 hours live + 4 hours self-paced
Total intervention hours	48 hours	48 hours	48 hours
Feedback type	Immediate verbal + written	Delayed written only	Immediate verbal + delayed written
Peer interaction	Live collaborative tasks	Asynchronous forum posts	Live tasks + forum posts
Instructor scaffolding	Real-time ZPD mediation	Delayed ZPD mediation	Dual-mode ZPD mediation
Content delivery	Live instruction	Pre-recorded lectures	Live + pre-recorded
Sessions per week	3 × 2 hours	3 × 2 hours	1 × 2 hrs live + 2 × 2 hrs async

Note. SLG = Synchronous Learning Group; ALG = Asynchronous Learning Group; BLG = Blended Learning Group; LMS = Learning Management System. Source: Authors' own work.

The SLG attended all instruction as live Zoom sessions, with a teacher on hand throughout to provide instant feedback and facilitate group writing tasks. The ALG was delivered entirely via Moodle, with students watching pre-recorded lectures, submitting written assignments, and exchanging feedback with classmates through discussion boards; instructors typically returned feedback within 24 to 48 hours. The BLG had one live two-hour Zoom session per week and spent the remaining four hours engaging with asynchronous Moodle content and forum discussions. This combination—real-time scaffolding plus structured asynchronous consolidation—was the practical realization of the dual-mode ZPD framework the study was designed to test (Dziuban et al., 2024).

Post-Intervention Phase

All participants completed the post-test writing task under conditions similar to the pre-test, one week after the final intervention session. Scripts were anonymized and re-scored by the same two raters; the post-test ICC was .89, confirming that rater consistency had been maintained. All post-test samples were imported into NVivo 14 and coded against the same four-node framework used at baseline.

2.5 Data Analysis

Quantitative data were analyzed using IBM SPSS Statistics 29. Independent samples t-tests were used to compare pre-test scores across groups (establishing baseline equivalence) and to compare post-test scores pairwise across groups. A multiple regression model was fitted to examine how effectively instructional modality, controlling for pre-test writing ability, predicted

post-test outcomes. Qualitative data were analyzed in NVivo 14 using the four-node coding framework described above. NVivo outputs and statistical findings were subsequently brought together at the interpretation stage, as a convergent mixed-methods design requires (Creswell & Creswell, 2023).

3. Results

3.1 Preliminary Analyses: Establishing Baseline Equivalence

Pre-test NVivo coding showed the three groups to be closely matched before the intervention began. The frequency of cohesive devices per paragraph was 4.2 (SLG), 4.0 (ALG), and 4.3 (BLG); type-token ratios were similarly flat, at 0.51, 0.49, and 0.52 respectively. Thematic

elaboration coding showed that the majority of students across all three groups produced writing classified at the surface tier, a cohort-wide baseline rather than a group-specific pattern. Syntactic complexity indices, derived from subordinate clause, passive construction, and complex noun phrase frequency relative to sentence count, were statistically indistinguishable across the three groups.

Independent samples t-tests conducted on pre-test writing scores confirmed what the NVivo coding had suggested: there were no statistically significant differences between any pair of groups before the intervention began. Pre-test means sat close together—SLG: $M = 42.3$ ($SD = 5.1$); ALG: $M = 41.8$ ($SD = 4.9$); BLG: $M = 42.6$ ($SD = 5.3$), as shown in Table 3. Null hypothesis H_0 was therefore retained.

Table 3 Independent Samples t-Test Results: Pre-Test Group Equivalence

Comparison	M1 (SD)	M2 (SD)	t (df=78)	p	Cohen's d
SLG vs. ALG	42.3 (5.1)	41.8 (4.9)	0.45	.656	0.10
SLG vs. BLG	42.3 (5.1)	42.6 (5.3)	0.26	.797	0.06
ALG vs. BLG	41.8 (4.9)	42.6 (5.3)	0.70	.485	0.11

Note. SLG = Synchronous Learning Group; ALG = Asynchronous Learning Group; BLG = Blended Learning Group. Cohen's d values below 0.20 indicate the three groups entered the study on essentially the same footing, meaning any post-test differences can reasonably be attributed to the instructional treatment rather than to pre-existing variation. Source: Authors' own work.

3.2 Post-Test NVivo Coding: What Changed and How

NVivo coding of post-test samples revealed substantial differences across all four nodes, with the BLG consistently showing the most developed writing profile. Cohesive device use grew most noticeably in the BLG, from a pre-test mean of 4.3 to a post-test mean of 9.7 per paragraph, a gain of 5.4 devices; the SLG gained 3.6 devices over the same period, and the ALG gained just 1.9. This pattern suggests that blended instruction was markedly more effective at helping students learn to connect ideas explicitly at the discourse level, one of the features that distinguishes competent academic writing from less developed prose.

Lexical diversity followed a similar gradient: BLG post-test TTR = 0.74, SLG = 0.65, ALG = 0.57. The 0.17 TTR-point gap between BLG and ALG represents a meaningful difference in vocabulary range and signals that blended learners were drawing on a considerably richer and more varied lexical repertoire by the end of the study. BLG writing samples had also shifted clearly from surface to deep elaboration: students in this group constructed multi-layered arguments supported by reasoning and specific evidence rather than merely asserting positions—precisely the developmental trajectory that ZPD-informed scaffolding is intended to produce, the movement from externally supported performance to genuinely

internalized competence (Lantolf & Poehner, 2021). The ALG remained largely at the surface-to-intermediate boundary. The SLG fell in

between: real progress on cohesion and syntactic complexity, but without the full elaboration depth that BLG students demonstrated.

Table 4 NVivo Node Metrics for All Three Groups at Pre-Test and Post-Test

NVivo Node	SLG Pre	SLG Post	ALG Pre	ALG Post	BLG Pre	BLG Post
Cohesive Device Frequency (/para)	4.2	7.8	4.0	5.9	4.3	9.7
Lexical Diversity (TTR)	0.51	0.65	0.49	0.57	0.52	0.74
Thematic Elaboration (dominant tier)	Surface	Intermediate	Surface	Surface–Inter.	Surface	Deep
Syntactic Complexity Index	0.38	0.61	0.36	0.47	0.39	0.79
NVivo Coding Coverage (%)	38	61	37	49	39	74

Note. SLG = Synchronous Learning Group; ALG = Asynchronous Learning Group; BLG = Blended Learning Group; TTR = Type-Token Ratio. Inter-coder reliability: Cohen's $\kappa = .87$. Source: Authors' own work.

3.3 Post-Test Statistical Analysis: Group Comparisons

Post-test independent samples t-tests told the same story through a different lens. Every pairwise comparison was significant, and effect sizes were large to very large by Cohen's (1988) benchmarks, as shown in Table 5. The hierarchy

that emerged—BLG > SLG > ALG—held consistently across both the quantitative scores and the qualitative coding. This alignment across data strands suggests that the numerical differences reflect genuine differences in writing development rather than artefacts of scoring. Null hypotheses H02, H03, and H04 were all rejected.

Table 5 Independent Samples t-Test Results: Post-Test Pairwise Group Comparisons

Comparison	M1	M2	t (df=78)	p	Cohen's d
SLG vs. ALG	68.4	61.7	4.54***	< .001	0.98 (Large)
BLG vs. SLG	76.9	68.4	8.23***	< .001	1.39 (Large)
BLG vs. ALG	76.9	61.7	11.51***	< .001	2.21 (Very large)

Note. *** $p < .001$ (two-tailed). Cohen's d: small $\geq .20$, medium $\geq .50$, large $\geq .80$, very large ≥ 2.00 (Cohen, 1988). SLG = Synchronous Learning Group; ALG = Asynchronous Learning Group; BLG = Blended Learning Group. Source: Authors' own work.

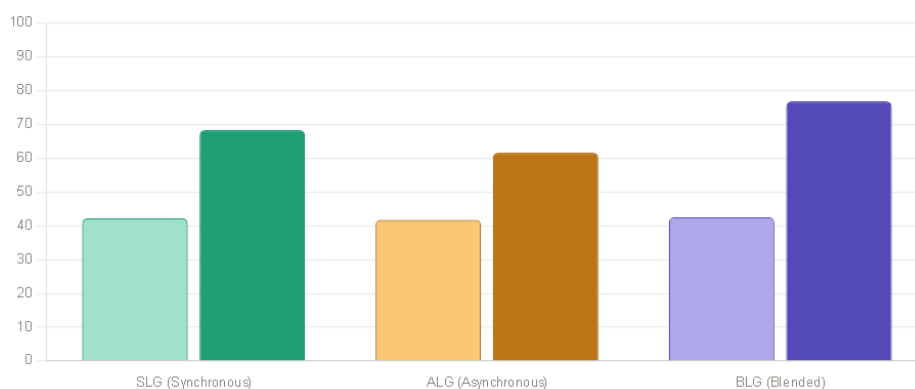


Figure 1 Pre-Test and Post-Test Mean Writing Scores across Experimental Groups (out of 100)

3.4 Regression Analysis: Predicting Post-Test Achievement

A multiple regression model was fitted to investigate how effectively instructional modality, controlling for pre-test writing skill, predicted post-test outcomes. The model was significant and explained a large proportion of variance in post-test scores, $F(3, 116) = 82.16$, $p < .001$, $R^2 = .68$, adjusted $R^2 = .67$. In sum, the combination of instructional modality and baseline ability explained 68% of the variance in post-test writing achievement. Blended

instruction was the strongest single predictor ($\beta = .71$, $t = 13.18$, $p < .001$, 95% CI [.63, 0.79]), followed by synchronous instruction ($\beta = .48$, $t = 8.36$, $p < .001$, 95% CI [.37, 0.59]) and asynchronous instruction, which was also significant but less robust ($\beta = .29$, $t = 3.59$, $p = .001$, 95% CI [.12, 0.46]). Pre-test score made a small but significant independent contribution ($\beta = .18$, $t = 2.98$, $p = .003$). Even after accounting for where students started, the type of instruction they received made a substantial and consistent difference to where they ended up. Null hypothesis H05 was rejected.

Table 6 Multiple Regression Results: Predicting Post-Test Writing Achievement

Predictor	Std. β	t	p	95% CI
Blended instruction	.71	13.18	< .001	[.63, .79]
Synchronous instruction	.48	8.36	< .001	[.37, .59]
Asynchronous instruction	.29	3.59	.001	[.12, .46]
Pre-test score	.18	2.98	.003	—

Note. Model fit: $F(3, 116) = 82.16$, $p < .001$, $R^2 = .68$, adjusted $R^2 = .67$. All coefficients are standardised. Source: Authors' own work.

4. Discussion

4.1 Interpreting Findings through the Dual-Temporal ZPD Model

Blended instruction, grounded in ZPD principles, produced the most positive writing outcomes, and this conclusion does not rest on a single metric but is consistent across quantitative scores, qualitative coding, and regression analysis. This convergence across data strands is

significant in applied linguistics research and makes the findings harder to dismiss. Crucially, these results provide empirical validation for the dual-temporal ZPD scaffolding model proposed in this study—the first framework to theorize synchronous and asynchronous instruction not merely as delivery alternatives but as activating qualitatively distinct temporal zones within the ZPD. The BLG's post-test mean of 76.9 and regression coefficient of $\beta = .71$ reflect what

happens when both temporal zones of the ZPD are adequately engaged. In the dual-temporal model, synchronous Zoom sessions activate the immediate ZPD zone, where real-time feedback, collaborative tasks, and instructor-mediated error correction provide the responsive scaffolding that learning in the proximal zone requires. The asynchronous Moodle components then activate the reflective ZPD zone, giving students the time and cognitive space to process, consolidate, and begin to internalize what was modelled in live interaction. Neither zone alone is sufficient; it is their deliberate sequencing within a blended design that produces genuine developmental gain. NVivo data corroborate this reading directly: BLG participants ended the study with the highest TTR (0.74), the highest cohesive device frequency (9.7 per paragraph), and the deepest elaboration tier, all indicators of the kind of independent writing competence that Lantolf and Poehner (2021) associate with successful ZPD internalization.

4.2 Modality-Specific Patterns: Synchronous and Asynchronous Trajectories

The SLG's trajectory is also instructive. A post-test mean of 68.4 and $\beta = .48$ represent genuine improvement, particularly in syntactic complexity and cohesive device use—real-time Zoom scaffolding clearly did something. But the format's structural limitations also showed: without built-in time for reflection and independent practice, metacognitive consolidation was harder to achieve, and thematic elaboration remained at an intermediate level. This is consistent with what Kohnke and Moorhouse (2023) found in their examination of synchronous language learning, namely that immediacy is a double-edged quality. The ALG's results ($M = 61.7$, $\beta = .29$) are worth considering carefully. The limitation here was not the format as such; asynchronous environments can support language development under the right conditions. Rather, first-year B.Tech students are still developing the self-regulatory capacity that asynchronous learning demands. Without a live teacher shaping the pace and direction of learning, and without the social accountability of

a shared classroom, many of these students found it difficult to push into and through their ZPD independently (van de Pol et al., 2022).

4.3 Extending the Model: Jingles as Scaffolds for First-Year B.Tech Learners

The present experiment did not include a jingle component, and none of the results reported above should be attributed to one. The pattern of findings nevertheless suggests where jingles might add value. The ALG's weaker outcomes were interpreted as reflecting first-year students' limited self-regulatory capacity when working alone, and the SLG's difficulties as reflecting insufficient time for reflection and consolidation. Jingles are one way of strengthening exactly these weak points. In the immediate zone, a live session could be used for teacher modelling of a short jingle that encodes target items, choral performance, and the collaborative composition of new verses in mixed-ability groups, with the instructor offering contingent hints (Lantolf & Poehner, 2021; van de Pol et al., 2022). In the reflective zone, the asynchronous platform could hold a recording of the jingle for repeated listening, a forum task in which students post their own verses and comment on those of peers, and short recall tasks in which learners reproduce the target words and structures without the melody. This sequencing would keep the essential features of the dual-temporal model—real-time mediation followed by structured consolidation—while giving learners an engaging, portable tool they can rehearse independently, one that may reduce the anxiety and boredom often associated with compulsory English modules (Murphey, 1992; Engh, 2013).

These suggestions should be treated as hypotheses. Benefits reported in the music-and-language literature come mainly from studies of vocabulary and recall (Ludke et al., 2014; Schön et al., 2008; Wallace, 1994), and it is not yet known whether they extend to paragraph-level writing or to the cohesive, lexical, and syntactic indices used in this study. It is also unclear how much of any effect arises from rhythm and melody as such, and how much from the collaborative composition that the sociocultural

perspective would emphasize. A logical next step is a controlled study in which blended instruction with a jingle component is compared with blended instruction without one, using the same pre-test and post-test writing tasks, the same NVivo nodes (especially cohesive device frequency and type-token ratio), a delayed post-test to examine retention, and a measure of learner motivation and anxiety. Such a design would test directly whether jingles strengthen the reflective zone of the ZPD for first-year B.Tech students and would allow the effect to be reported with appropriate effect sizes and confidence intervals.

5. Conclusion

Pedagogical Implications

The findings carry direct implications for EFL educators in engineering undergraduate settings. A consistent BLG > SLG > ALG hierarchy emerged across every data strand, with the regression model accounting for 68% of post-test writing variance ($R^2 = .68$; $F(3, 116) = 82.16$, $p < .001$). Blended programmes, designed with explicit attention to how synchronous and asynchronous components complement each other, are likely to produce better writing outcomes than either mode alone. Where full blended infrastructure is not available, even modest additions—a structured online discussion component added to a mainly synchronous course, or a weekly live session used to anchor an otherwise asynchronous programme—may meaningfully improve outcomes.

Theoretical and Methodological Contributions

Beyond its empirical findings, this study offers two original contributions to the field. The first is the dual-temporal ZPD scaffolding model, a conceptual framework that distinguishes between the immediate ZPD zone, activated by synchronous instruction through real-time mediation and responsive feedback, and the reflective ZPD zone, activated by asynchronous instruction through delayed consolidation and independent practice. The model reframes blended learning not as a logistical compromise

between two formats but as the only modality that structurally engages both temporal dimensions through which ZPD-based internalization proceeds. The second contribution is methodological: the integration of NVivo 14 node-level coding with multiple regression in a convergent mixed-methods design generates a more textured account of writing development than either method could produce alone, and offers a replicable template for researchers working in similar applied linguistics contexts.

Implications for Future Research and Jingles

A further implication concerns jingles. Although not tested here, jingles are a promising, low-cost scaffolding tool that could be embedded in both the live and self-paced components of a blended programme for first-year B.Tech students, for example to consolidate cohesive devices, technical vocabulary, and grammatical patterns. Future studies should evaluate their impact on English language learning, including writing, retention, and motivation, within the dual-temporal ZPD framework proposed in this paper. The study's limitations should also be acknowledged. The sample came from a single institution, the intervention lasted eight weeks, and individual-level variables such as technology familiarity and self-regulatory skill were not measured systematically at baseline. Future research would benefit from multi-site designs, longer observation periods, and qualitative methods—interviews and think-aloud protocols—that can get closer to students' own experience of being scaffolded in different environments. Testing the dual-temporal ZPD model in various disciplinary and linguistic contexts would increase its generalizability.

This study set out to answer a straightforward practical question: for first-year engineering undergraduates learning to write in English, does it matter how instruction is delivered? The answer, on the basis of this data, is yes, and the difference is not small. Blended learners did not just score higher; they wrote differently. They elaborated arguments more fully, used more varied vocabulary ($TTR = 0.74$), and constructed

more syntactically complex sentences (index = 0.79)—the marks of writing that has moved beyond surface performance into something more genuinely developed, which is, ultimately, what ZPD-informed instruction aims to produce. The findings provide a starting point for thinking about how instructional format shapes writing development in this demographic, and for theorizing why blended instruction works when it does.

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7. Author Declaration

- The authors confirm that this manuscript is their original work, has not been published elsewhere, and is not under consideration for publication elsewhere.
- The authors declare no conflict of interest.

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