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The Convergence of Technology and Pedagogy: Boosting EFL Writing Skills through Google Docs as a Cloud-Based Tool and Collaborative Learning Environment

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Abstract

The present study explored the effectiveness of Google Docs as a cloud-based technology in enhancing the complexity, accuracy, and fluency (CAF) facets of writing competence. Forty-nine Iranian EFL learners, majoring in English, from two intact classes participated in the study. The classes were randomly assigned to the Google Docs (GD) group and the Conventional Teaching group (CT) after their proficiency levels were identified. The GD group ($n=25$) used the Google Docs writing instruction platform, while the CT group ($n=24$) received traditional writing instruction. Furthermore, ten students from the Google Docs group participated in semi-structured interviews to express their perceptions of the treatment they received. A mixed-methods design, incorporating Multiple Analysis of Covariance (MANCOVA) and theme-based analysis, was employed to assess quantitative and qualitative outcomes. The findings indicated that the GD group demonstrated a significantly improved ability in CAF writing compared to the CT group. The interviews revealed several important themes, including the positive experiences associated with collaborative writing through Google Docs, the convenience and flexibility of real-time collaboration, and the effectiveness of peer support in enhancing writing competence. Additionally, the teacher's role as a facilitator was found to be crucial. Overall, the results suggested that the interactive attribute of Google Docs, combined with peer correction and editing, noticeably supports more sophisticated and accurate writing skills.

Keywords: Google Docs, writing instruction, writing complexity, accuracy, and fluency, mixed-methods study

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1. Introduction

Developing writing competence is pivotal within the English as a Foreign Language (EFL) framework. In the academic context, writing provides several benefits to learners (Genç-Ersoy & Göl-Dede, 2022). Writing mastery is essential for success in various aspects, including academic pursuits, as highlighted by Brown et al. (2023). Additionally, writing can serve as a supportive tool to facilitate the learning of a second language and encourage students to explore and enhance their language skills (Hemati & Farahian, 2024). Due to the multifaceted nature of writing, some experts refrain from treating it as a unitary concept and instead view it from different perspectives. In this line, writing development has been conceptualized as an improvement in Complexity, Accuracy, and Fluency (CAF) by some L2 writing researchers (Ellis & Barkhuizen, 2005; Skehan, 2009), who believe that writing development involves improving CAF. Ellis and Barkhuizen (2005) put forward that complexity is the enrichment and sophistication of language use, encompassing varied sentence structures, a diverse vocabulary, and rhetorical devices to convey meaning effectively. As Johnson (2017) states, accuracy pertains to the grammatical correctness of writing (error-free), which encompasses correctly applying grammar, syntax, and punctuation to ensure that the intended meaning is communicated precisely to the reader. Fluency, the third aspect of CAF, manifests the smoothness and coherence of the written text. It reflects the writer's ability to maintain a logical flow of ideas, effectively linking sentences and paragraphs to create a cohesive composition. Fluent writing is marked by the absence of awkward transitions, disruptions, or inconsistencies that may impede the reader's understanding or engagement (Ellis, 2009). Consequently, the literature has extensively studied CAF dimensions of writing proficiency (Imsa-ard & Barrot, 2024; Phuoc & Barrot, 2022; Yang & Kim, 2020).

Due to the multifaceted nature of writing, some experts refrain from considering writing as a unitary concept and regard it from different perspectives. Skehan (2014) identified a conflict within the components of the CAF, referring to it as a trade-off effect. This effect suggests that when an individual concentrates on one aspect of CAF, it can hinder their ability to focus effectively on another component. In line with the proposed model in psycholinguistics (Griffin & Ferreira, 2006), Skehan predicted a competitive relationship among complexity, accuracy, and fluency due to the limited mental resources, especially limited attentional capacity and working memory. In Skehan's limited attentional model, a learner cannot simultaneously attend to all components of language performance. A body of research in L2 learning in general and writing, in particular, has advocated Skehan's perspective. For example, Adams et al. (2015) concluded that learners who performed more complex tasks produced more complex and less accurate writing. However, reducing task complexity and providing language support led learners to pay greater attention to writing accuracy. In their study, Rashtchi and Mohammad Yousefi (2017) also found that students often split their attention between complexity and accuracy. The results underscored a significant accomplishment in grammatical complexity, achieved at the expense of accuracy.

Furthermore, the complex nature of writing has led other educators to approach the subject in different ways. Avoiding treating it as an isolated task, educators argue that collaborative writing can transform the daunting challenge of writing into a more manageable endeavor. This approach not only supports the writing process itself but can also influence aspects of CAF to varying degrees. Collaborative writing, defined by Storch (2013) as an effective instructional activity, has been widely employed in L2 classrooms over the last few decades. Previous research has reported numerous benefits of collaborative writing, including enhanced audience awareness, increased attention to language forms and discourse, and opportunities to apply newly acquired knowledge (Storch, 2013). In a research study, Nation (2009) concluded that cooperative writing involved students engaging in a collective process where they interacted and negotiated meaning. They increased their sense of companionship, made joint decisions throughout this activity, sharing responsibility and co-ownership of the resulting text. Such cooperation enables learners to refine ideas together, resolve language issues, and construct more cohesive and accurate writing through shared reflection and mutual support. This collaborative effort enhances communication skills, fosters critical thinking, and promotes creative problem-solving among participants, making it a valuable educational practice. Other investigations have examined the potential role of interactions among participants within collaborative writing contexts in encouraging overall growth in writing competence (Cho, 2017; Li & Zhang, 2023; Storch, 2013; Wang et al., 2024; Zhang & Plonsky, 2020).

Accordingly, it is important to address challenges associated with writing to effectively resolve ongoing issues, as many EFL learners encounter considerable difficulties in this area. These challenges often stem from conventional, teacher-led educational methods that emphasize rote memorization. Such approaches limit opportunities for active engagement and may stifle learners' creativity and critical thinking (Rashtchi & Khoshnevisan, 2020). In response to the existing issues, scholars and educators have increasingly explored innovative pedagogical strategies and technologies designed to promote learner engagement and increase writing proficiency (Godwin-Jones, 2018; Li & Zhang, 2023). An emerging technology that has gained significant attention in L2 writing instruction is Google Docs, which offers distinctive attributes that enhance collaborative writing and peer feedback. Google Docs furnishes opportunities for immediate interaction in authentic situations to critique one's work constructively. It is a cloud-based platform that streamlines the online creation, editing, and storage of written content. In essence, documents are stored on remote servers rather than local devices, enabling users to access their work from diverse digital tools. In a study, Ningsih (2023) highlighted that students appreciated the platform's real-time editing features, such as Google Docs, that facilitate seamless cooperation, enrich learners' writing skills, and enhance a sense of accountability in gaining knowledge.

Google Docs depicts strong potential for enhancing L2 writing collaborative instruction; however, there exists a scarcity of research explicitly verifying its effectiveness in the written outcomes of EFL learners. Therefore, it is essential to conduct additional empirical investigations to assess its effectiveness compared to other digital tools in educational contexts. The present study

aims to provide guidance on best practices for integrating technology into EFL curricula, demonstrating the effectiveness of Google Docs in enhancing EFL learners' CAF writing. The incentive for this study arises from exhibiting limitations of traditional teacher-centered instruction in EFL University contexts in Iran, where students often struggle to achieve satisfactory academic outcomes (Naghdiipour, 2016).

In addition, this study employed Vygotsky's social constructivism (Vygotsky, 1978) to enhance collaborative and co-constructive writing activities. The theory was operationalized through scaffolded peer interactions and teacher mediation within Google Docs, where learners jointly constructed texts, exchanged feedback, and negotiated meaning in real time. This collaborative environment reflected Vygotsky's emphasis on the Zone of Proximal Development (ZPD), enabling learners to advance linguistic performance through guided support and social co-construction. Social engagement and contribution are vital components of the learning process for students, as they enhance engagement in collaborative work (Ammar & Hassan, 2018). In interactions, learners collaborate on linguistic problem-solving and knowledge building to accomplish tasks beyond their individual capabilities. The cooperative approach fosters mutual support among learners, enhancing both their linguistic expertise and attention to relevant aspects of language learning (Ohta, 2001). Thus, by engaging EFL students in cooperative writing, the study provided numerous opportunities for them to tackle various writing tasks, thereby encouraging deeper understanding and skill development in written communication. This approach supported individual growth and emphasized the importance of social interaction in the learning process. Incorporating Google Docs into instructional procedures can facilitate peer interaction, feedback exchange, and collaborative writing experiences, which are influential components in L2 writing enhancement. Additionally, the findings can cultivate educational practices to interplay between technology, societal interaction, and intellectual growth. Consequently, the study may provide practical recommendations for teachers and educators on integrating Google Docs and other Web 2.0 tools into EFL writing education, thereby enhancing interactive opportunities for EFL learners.

2. Literature Review

2.1. Writing CAF

The dimensions of writing known as CAF are interconnected in writing tasks, exhibiting varying degrees of interdependence based on the specific task. Assessing the CAF of L2 learners is essential to boost language skills in response to particular tasks, instructional methods, and input formats. In their research, Norris and Ortega (2009) emphasized the need to address challenges related to the concept of CAF. They argued for a stronger connection between theoretical frameworks and language skill improvement in this field. Additionally, they advocated for incorporating multidimensionality and dynamicity as central aspects of future CAF research, highlighting the merits of these elements in acquiring language and appraisal practices.

Lambert and Kormos (2014) analyzed the observable facets of CAF within the context of L2 performance. They argued that these measurable linguistic features provide insight into how effectively a student's written text reflects these dimensions. By examining the CAF elements, educators can categorize and assess the written productions of EFL students, gaining a deeper understanding of their language proficiency and performance levels. This framework serves as a crucial tool for evaluating and improving language learning outcomes. According to Housen et al. (2012), cognitive processes contribute to CAF, with higher complexity and accuracy levels typically associated with advanced L2 proficiency and the restructuring of interlanguage. Similarly, Martínez (2018) elaborated on the syntactic complexity of argumentative essays, carefully controlling both the essay topics and the time constraints to ensure the comparability of results. The findings underscored that the intermediate group achieved significantly better grades across all complexity measures, excluding the simple sentence ratio. Moreover, Adams et al. (2015) investigated students' writing accuracy and complexity within collaborative online problem-solving tasks, highlighting the role of communication in managing writing challenges. The results demonstrated that students engaged in more sophisticated tasks produced writing with greater complexity but lower accuracy. In contrast, by simplifying task complexity and providing language support, participants could enhance their focus on improving writing accuracy.

2.2. Collaborative Writing

The current investigation is grounded in Vygotsky's theory of social constructivism, which argues that mental capabilities are developed through interactions with more knowledgeable peers. According to Vygotsky (1978), cultural achievement occurs on a social plane before progressing to an individual cognitive level. Thus, collaborative interactions are effective in facilitating the acquisition of higher cognitive processes. Pavlenko and Lantolf (2001) outlined that collaborative learning is a social process wherein second language knowledge is actively shared and constructed through collective activities within a community. This approach emphasizes that individuals initially develop advanced cognitive skills through cooperative engagement.

Additionally, collaborative writing activities that promote interaction among L2 learners facilitate the co-construction of knowledge and offer numerous benefits. These activities require consideration of grammar, vocabulary, and discourse, leading to collaborative texts that exhibit greater syntactic complexity and enhanced precision in grammar and lexicon compared to solitary writing endeavors. Along the same line, Davison (2024) probed the progress of communicative language in pupils' writing, accompanied by their participation in collaborative or independent writing. Based on the study's results, when the pupils participated in the cooperative activity, they could improve their accuracy; however, the writing complexity and fluency dimensions remained unchanged. Neumann and McDonough (2014) also found that collaborative dialogue enhances learners' problem-solving and knowledge-building capabilities across diverse proficiency levels.

This type of dialogue identifies the problematic sections, offers solutions, and promotes the integration of diverse linguistic strengths, ultimately leading to rich written outputs and furthering L2 acquisition.

2.3. Google Docs-Mediated Collaborative Writing

The use of computer-assisted techniques, particularly in collaborative writing settings, has recently garnered considerable attention. The literature suggests that the use of technology has a positive influence on L2 writing. In their research, Chan and Ridgway (2006) found that while evidence regarding the consistent enhancement of learning through educational technologies remains inconclusive, exploring innovative ways of incorporating them into teaching and learning practices is crucial. Researchers have increasingly focused on the worthiness of merging technology into pedagogy. For instance, Pham and Usaha (2016) observed the peer responses via blogs, which resulted in more revisions than traditional peer feedback. They demonstrated that Computer-Assisted Language Learning (CALL) overcomes time constraints in traditional classes by enabling collaborative participation and peer correction, thereby enhancing academic written competencies.

The shift to student-centered, social constructivist teaching methods has led to innovative evaluations of EFL learners. One notable approach is implementing Google Docs for joint writing. The accessible characteristics of the Web 2.0 tool facilitate the convenient distribution of materials on a dedicated online platform, enabling educators to monitor projects and allowing multiple users to edit documents simultaneously. Its revision history trait aids users in tracking changes and reviewing previous versions.

In L2 writing education, a wealth of empirical research has demonstrated the encouraging influence of Web 2.0 digital spaces, such as blogs and wikis, on boosting written skills (Bikowski & Vithanage, 2016). Marandi and Seyyedrezaie (2017) differentiated the use of Google Drive from traditional in-person education, concluding that Google Drive was more effective in enhancing writing capability and alleviating writing anxiety. Ebadi and Rahimi's (2017) study highlighted that participants who used Google Docs for online peer assessment showed an improvement in their writing ability compared to those receiving face-to-face writing instruction. Additionally, Zhou et al. (2012) assessed the effectiveness of Google Docs for cooperative written work and learning competencies, as evidenced by participants' positive experiences.

The researchers of this study aimed to highlight the merits and benefits of utilizing Google Docs in writing instruction and group work learning achievements. However, they argue that it is essential to consider that while Google Docs presents several advantages for collaborative written productions, research on its effectiveness compared to alternative Web 2.0 tools, namely blogs and wikis, still requires further investigation. Consequently, to more precisely verify the gaps and investigate the influential role of this eminent technology, the researchers employed an explanatory sequential design (Creswell et al., 2006). This method commenced with quantitative data collection,

followed by a qualitative lens to construct additional insights and raise the following research questions:

1. How does Google Docs-based writing instruction foster the development of complexity, accuracy, and fluency (CAF) dimensions of EFL learners' writing skills?
2. How do students experience the merits of Google Docs-based education to develop their writing skills?

3. Method

3.1. Participants

The present study engaged 49 Iranian EFL students from two campuses of Islamic Azad University in Tehran, who were enrolled in a mandatory writing course. Participants ranged in age from 20 to 24 years ($M=21.36$, $SD=2.58$). The sample included both male and female students, providing a balanced demographic representation for the research. This course spanned 13 weeks and was worth two credits. The study employed a random assignment process to allocate learners into two groups: a Google Docs (GD) group of 25 and a Conventional Teaching (CT) group of 24. Both groups received instruction from the same instructor, who was experienced in integrating technology into language learning. The Oxford Placement Test (OPT) was administered to ensure baseline equivalence in English proficiency among the participants.

3.2. Instruments

3.2.1. Oxford Placement Test (OPT)

OPT was implemented to estimate the homogeneity of the participants. The test encompassed 60 items to measure essential syntax, lexis, and reading skills. Allan (2004) emphasized the reliability and accuracy of OPT in evaluating and classifying English learners into appropriate proficiency levels. Allan argues that OPT is standardized against proficiency levels derived from the Common European Framework of Reference for Languages (CEFR), the Cambridge ESOL Examinations, and various prominent assessments.

3.2.2. Timed Writing Essays

The participants took two 50-minute written tasks as pretest and posttest measures. The topics for each task were general. The pretest topic was: *"Do you agree or disagree with the following statement? People are never satisfied with what they have; they always want something more or something different. Use specific reasons to support your answer."* The posttest topic was: *"Do you agree or disagree with the following statement? Only people who earn a lot of money are successful. Use specific reasons and examples to support your answer."* Before selecting the topics,

ten topics were adapted from *501 Writing Prompts* (2003), and 20 students with similar characteristics to the study's participants were asked to rate the topics according to their interests.

3.2.3. CAF Measures

Writing complexity was examined using diverse indicators, including the proportion of clauses to T-units (Levkina & Gilabert, 2012), the ratio of words to clauses, and the ratio of dependent clauses to clauses (Skehan & Foster, 2012). Writing accuracy was assessed by calculating the percentage of error-free clauses and “T-units” (Knoch et al., 2015). Writing fluency was assessed through evaluation, measured by the number of words, number of T-units, and T-unit length, which refers to the average number of words per T-unit (Wigglesworth & Storch, 2012). Specific writing dimensions employed in the present academic work, including complexity, accuracy, and fluency (CAF), are listed in Table 1 (extracted from Fathi & Rahimi, 2020).

Table 1
List of Employed Measures for Writing CAF

Categories	Measures
Complexity	Clauses per T-unit (C/T)
	Words per clause (W/C)
	The ratio of dependent clauses to clauses (DC/C)
Accuracy	Error-free Clauses (EFC/C)
	Error-free T-units (EFT/T)
Fluency	Number of words (NW)
	Number of T-units (NT)
	T-unit length (TL)

3.2.4. Interview

The researchers conducted individual in-person interviews, implementing Google Docs to gather insights into participants' perspectives on the collaborative writing course. The qualitative interviewing method was selected, emphasizing active engagement and dialogue between the interviewer and interviewee (Rubin & Rubin, 2005). The semi-structured interviews allowed for flexibility in the questioning process, without a fixed order of questions, enabling participants to articulate their views in an informal setting. As a result, the responses were not limited to predefined categories, allowing for a thorough exploration of participants' experiences.

3.3. Procedure

Data were gathered from two campuses of Islamic Azad University in Tehran province, Iran. OPT confirmed the participants' homogeneity, compiled from two intact classes, before the commencement of the writing course. The classes were randomly assigned to the GD and CT groups. The GD group received writing instruction that integrated Google Docs alongside peer

assessment, whereas the CT group engaged in traditional writing instruction without employing Google Docs.

At the outset, both groups accomplished a timed writing assignment (Topic A) as a pretest. The writing course was designed to familiarize English major students with various paragraph types, including descriptive, process, opinion, comparison/contrast, and solution paragraphs. The instructor (one of the researchers) presented each paragraph type, after which students were assigned to draft a sample of each type as homework. The writing process involved multiple drafts, where students produced an initial draft, received feedback, revised their work, and ultimately submitted a final draft. The instructor provided them with a sample video illustrating the peer editing procedure and comprehensive explanations of essential writing elements such as “content,” organization, language use, vocabulary, and mechanics. Moreover, written tasks were assessed and edited by peers in both groups. The same instructor delivered instruction to both groups, using identical materials and content.

For the GD group, students created Google Docs that were accessible to their peers and the instructor. The teacher provided ongoing feedback on the writing tasks, monitoring critical areas, including content, organization, language use, vocabulary, and mechanics. Participants shared their initial drafts via Google Docs for peer assessment and feedback, as well as revisions, and produced subsequent versions incorporating further rectifications until the completion of the eventual draft. The process entailed writing the initial draft, sharing it with other pupils on Google Docs for peer reviewing, and generating further drafts based on feedback from peers and the instructor. In other words, while the instructor monitored the learners, they provided comments on each other’s writing tasks using Google Docs synchronously. The learners rectified their peers’ work with a distinct “font color.” Conversely, in the CT Group, participants adhered to the same writing structure and completed similar assignments collaboratively. The instructor formed groups of three or four to facilitate peer editing within each group. After the writing course, both groups undertook a timed writing task (Topic B) as a posttest to enable the researchers to evaluate their written output.

Additionally, at the course’s conclusion, the researchers conducted a series of individual semi-structured interviews with a selected cohort of pupils from the GD group. The interviews explored the participants’ experiences and perceptions regarding the cooperative writing approach catalyzed through Google Docs.

3.4. Data Analysis

The Multivariate Analysis of Covariance (MANCOVA) was utilized to investigate this study’s first research question. In MANCOVA, statistical disparities in multiple continuous dependent variables (posttest scores gained on three facets of writing: complexity, accuracy, and fluency, measured with different pertinent measures) are assessed by an independent grouping variable (group: Google Docs-based writing instruction). The covariate (pretest scores obtained on

the three facets of writing) is the third variable examined. Covariates are used to minimize error by controlling their effects on the relationship between independent variables and continuous dependent variables. The researchers also thematically coded interview transcripts for qualitative data based on Auerbach and Silverstein (2003). This process identified themes related to participants' collaborative writing experiences in Google Docs. The qualitative findings complemented the quantitative results to validate the efficacy of Google Docs-based mediation on writing complexity, accuracy, and fluency.

4. Results

The inquiry comprised two intact groups: the GD group ($n=25$) and the CT group ($n=24$). An independent samples t-test was used to confirm the homogeneity of the two groups' OPT proficiency scores. Table 2 shows that the mean scores of the GD ($M=37.40$, $SD=5.31$) and CT groups ($M=36.27$, $SD=5.98$) are close to each other, with a mean difference of only 1.13. The results revealed that all assumptions of using parametric data analysis: interval data, independence of subjects, normality, and homogeneity of variances, were met. An independent samples t-test detected no significant difference, $t(47)=0.78$, $p=0.44$, in the English proficiency scores between the GD and CT groups. This finding suggests that students in both groups were intermediate homogeneous in terms of English language proficiency (Table 2).

Table 2
Descriptive Statistics and T-Test for OPT

Descriptive Statistics			T-Test for OPT				
Groups	N	Mean	SD	t	df	p	Mean Diff.
GD	25	37.40	5.31	.776	47	.441	1.133
CT	24	36.27	5.98				

Then, to assess the influence of Google Docs-based instruction and conventional teaching methods on students' written output, the researchers examined the difference in writing proficiency, measured through timed writing tasks, between the pretest and posttest for each group. As Table 3 displays, the mean scores for the two groups on the three measures of writing complexity appear to be close to each other on the pretest. Concerning three measures of writing complexity, the means score of clauses per t-unit in the GD ($M=1.27$, $SD=.14$) and CT ($M=1.23$, $SD=.12$), words per clause in the GD ($M=12.42$, $SD=3.91$) and CT ($M=12.74$, $SD=4.09$), the ratio of dependent clauses to clauses in the GD ($M=36.44$, $SD=4.74$) and CT ($M=35.60$, $SD=4.71$) were not very far from each other on the pretest. The same pattern was observed for writing accuracy and fluency, as well as their various measures.

Table 3
Descriptive Statistics (Pretest)

Variable	Group	N	Mean	SD	SEM
Aspect	Measure				
Complexity	C/T	GD	25	1.271	0.137
		GD	25	1.226	0.117
	W/C	GD	25	12.418	3.915
		CT	25	12.737	4.088
	DC/C	GD	25	36.440	4.744
		CT	25	35.600	4.708
	EFC/C	GD	25	72.085	5.451
		CT	25	70.077	6.048
	EFT/T	GD	25	66.453	5.050
		CT	25	65.577	5.019
Accuracy	NW	GD	25	309.520	12.275
		CT	25	311.240	12.262
	NT	GD	25	20.360	5.438
		CT	25	20.560	5.268
	TL	GD	25	15.704	3.937
		CT	25	16.003	3.981

As shown in Table 4, almost all mean scores for the three measures of writing CAF in the GD group seem noticeably higher than those of the conventional group. For example, in terms of writing complexity, the students in the GD group ($M=1.49$, $SD=.17$) achieved a higher mean score than those in the CT group ($M=1.37$, $SD=.13$) on Clauses per T-unit. Regarding Words per clause, participants in the GD group ($M=15.14$, $SD=3.62$) achieved a significantly higher mean score than those in the CT group ($M=14.35$, $SD=3.78$). Additionally, regarding the Ratio of dependent clauses to total clauses, students in the GD group ($M=47.48$, $SD=2.93$) demonstrated a notably superior mean score compared to their CT group counterparts ($M=44.96$, $SD=4.40$). This trend was similarly observed across various measures of writing accuracy and fluency.

Table 4*Descriptive Statistics (Posttest)*

Variable		Groups	N	Mean	SD	SEM
Aspect	Measure					
Complexity	C/T	GD	25	1.489	0.171	0.034
		CT	25	1.374	0.129	0.026
	W/C	GD	25	15.144	3.625	0.725
		CT	25	14.352	3.783	0.757
	DC/C	GD	25	47.480	2.931	0.586
		CT	25	44.960	4.402	0.880
	Accuracy	GD	25	80.869	6.909	1.382
		CT	25	74.247	6.950	1.390
		EFT/T	25	74.439	5.667	1.133
		CT	25	69.480	7.241	1.448
Fluency	NW	GD	25	337.960	17.843	3.569
		CT	25	330.640	16.765	3.353
	NT	GD	25	23.440	4.709	0.942
		CT	25	22.200	5.657	1.131
	TL	GD	25	18.225	3.773	0.755
		CT	25	17.243	3.929	0.786

The assumption of interval data is not violated as the present data are measured on an interval scale (Field, 2017). The homogeneity of variances results summarized in Table 5 show that the significant value associated with Levene's test for all three variables of writing (complexity, accuracy, and fluency) is larger than the selected significant level at .05; therefore, the assumption of homogeneity of variances was met for these three variables.

As seen in Table 5, the significant value associated with Levene's test for three measures of writing complexity, clauses per T-unit ($F(2, 48)=.04, p=.74$), words per clause ($F(2, 48)= .02, p=.88$), and ratio of dependent clauses to clauses ($F(2, 48)=.76, p=.39$), implying that the assumption of homogeneity of variances was not violated for the three measures. The same pattern was observed for different measures of writing accuracy and fluency.

Table 5*Levene's Test*

	Variable	F	df1	df2	p
Aspect	Measure				
Complexity	C/T	0.043	1	48	0.737
	W/C	0.016	1	48	0.881
	DC/C	0.758	1	48	0.388
Accuracy	EFC/C	2.059	1	48	0.158
	EFT/T	0.516	1	48	0.476
Fluency	NW	3.690	1	48	0.071
	NT	0.051	1	48	0.722
	TL	0.035	1	48	0.752

The results also showed that homogeneity of covariance was fulfilled (Box's = 52.98, $F=1.21$, $p=.18$). Since all assumptions were met, performing a one-way MANCOVA was legitimized.

Table 6 indicates that there was a significant difference in writing measures between the two groups on the posttest, as indicated by Wilks' Lambda=.40, $F(8, 33)=6.07$, and $p<.001$, while controlling for the pretest effect. The effect size was large, with $\eta^2=.59$.

Table 6
Multivariate Tests

Effect		Value	F	Hypo. df	Error df	p	η^2
Intercept	Pillai's Trace	0.334	2.068	8.000	33.000	0.068	0.334
	Hotelling's Trace	0.501	2.068	8.000	33.000	0.068	0.334
	Wilks' Lambda	0.666	2.068	8.000	33.000	0.068	0.334
	Roy's Largest Root	0.501	2.068	8.000	33.000	0.068	0.334
Group	Pillai's Trace	0.596	6.075	8.000	33.000	0.000	0.596
	Hotelling's Trace	1.473	6.075	8.000	33.000	0.000	0.596
	Wilks' Lambda	0.404	6.075	8.000	33.000	0.000	0.594
	Roy's Largest Root	1.473	6.075	8.000	33.000	0.000	0.596

Table 7 indicates significant differences in writing CAF between the GD and CT groups. For writing complexity, differences were noted in Clauses per T-unit ($F(1, 40)=5.858$, $p=.020$, $\eta^2=.13$), Words per clause ($F(1, 40)=6.495$, $p=.015$, $\eta^2=.14$), and Ratio of dependent clauses to clauses ($F(1, 40)=7.398$, $p=.010$, $\eta^2=.16$). In terms of writing accuracy, significant differences were found in error-free clauses ($F(1, 40)=8.930$, $p=.005$, $\eta^2=.18$) and error-free T-units ($F(1, 40)=9.72$, $p=.003$, $\eta^2=.20$). For writing fluency, differences were seen in the number of words ($F(1, 40)=6.292$, $p=.016$, $\eta^2=.14$), number of T-units ($F(1, 40)=4.782$, $p=.035$, $\eta^2=.11$), and T-unit length ($F(1, 40)=5.951$, $p=.019$, $\eta^2=.13$). Overall, the results revealed that across all dimensions, complexity, accuracy, and fluency, the GD group showed statistically significant improvements over the CT group, confirming the effectiveness of Google Docs-based instruction in enhancing learners' writing performance.

Table 7*Tests of Between-Subjects Effects*

Source	Depend. Vari.		Type III Sum of df			Mean Square	F	p	η^2
	Aspect	Measure	Squares						
Corrected Model	Complexity	C/T	.858	9	0.095	9.401	0.000	0.679	
		W/C	530.825	9	58.981	17.362	0.000	0.796	
		DC/C	513.322	9	57.036	9.616	0.000	0.684	
	Accuracy	EFC/C	2027.221	9	225.247	10.912	0.000	0.711	
		EFT/T	1550.540	9	172.282	8.769	0.000	0.664	
	Fluency	NW	7776.037	9	864.004	4.747	0.000	0.516	
		NT	1065.650	9	118.406	18.666	0.000	0.808	
		TL	576.747	9	64.083	17.386	0.000	0.796	
Group	Complexity	C/T	0.059	1	0.059	5.858	0.020	0.128	
		W/C	22.064	1	22.064	6.495	0.015	0.140	
		DC/C	43.883	1	43.883	7.398	0.010	0.156	
	Accuracy	EFC/C	184.321	1	184.321	8.930	0.005	0.182	
		EFT/T	190.984	1	190.984	9.721	0.003	0.196	
	Fluency	NW	1145.176	1	1145.176	6.292	0.016	0.136	
		NT	30.335	1	30.335	4.782	0.035	0.107	
		TL	21.936	1	21.936	5.951	0.019	0.130	
Error	Complexity	C/T	0.406	40	0.010	0.406			
		W/C	135.882	40	3.397	135.882			
		DC/C	237.258	40	5.931	237.258			
	Accuracy	EFC/C	825.669	40	20.642	825.669			
		EFT/T	785.887	40	19.647	785.887			
	Fluency	NW	7280.463	40	182.012	7280.43			
		NT	253.730	40	6.343	253.730			
		TL	147.432	40	3.686	147.432			

After analyzing the qualitative data, key themes emerged from the interviews, highlighting participants' experiences in the Google Docs-based writing course. These themes include positive attitudes toward collaboration, the convenience of real-time editing, improved writing skills through cooperative learning, and the effectiveness of peer mediation and tutors as facilitators (see Table 8).

Table 8*Themes and Sample Excerpts of Qualitative Results*

Theme	Sample Excerpt
Positive Attitudes towards Google Docs Collaboration	“I liked using Google Docs because it allowed us to work together seamlessly, editing the document in real-time. It made the writing process smoother and enhanced our collaboration.”
Convenience and Flexibility of Real-time Collaboration	“Google Docs allowed us to collaborate without needing to meet in person. We could access the document anytime, making it easier to coordinate our writing despite our busy schedules.”
Enhanced Writing Skills through Collaborative Learning	“Collaborative writing improved my skills through valuable peer feedback and discussions. This exchange of ideas made my writing more well-rounded and allowed us to learn from each other.”
Role of Peer Mediation in Writing Development	“Feedback from my peers highlighted my strengths and weaknesses, and their suggestions helped me improve my writing style and structure. Peer mediation was invaluable in refining my writing and making it more effective.”
Challenges and Benefits of Collaboration	“I was initially hesitant to share my writing, feeling vulnerable. However, collaborating with peers boosted my confidence, allowing me to express my ideas and receive constructive feedback. It motivated me to improve and made me feel part of a supportive community”.
Teacher's Role as a Facilitator	“Our teacher guided us through the writing process with clear instructions and valuable insights. They were always available for questions and gave constructive feedback, enhancing our growth as writers and making the collaborative experience more valuable”.

5. Discussion

The first research question in the present study investigated the degree to which collaborative writing instruction using Google Docs contributes to the development of EFL learners' writing CAF. Specifically, it aimed to determine which of the two groups, GD or CT, showed a significantly greater improvement in terms of CAF in writing. As the results revealed, the writing indicators showed significant improvement in the GD group. Additionally, the findings are consistent with Vygotsky's sociocultural theory, which explores the beneficial impact of mediation and the importance of peer guidance or editing on these writing dimensions within the EFL setting. One potential explanation is that collaboration, particularly in online platforms, fosters audience awareness, heightens attention to language forms and discourse, and provides opportunities for students to apply newly acquired knowledge (Storch, 2013). Therefore, the findings are situated within the framework of existing literature and the principles of social constructivism, underscoring the vital role of interaction in enhancing students' writing proficiency. By harnessing technological tools, tutors can elevate a supportive learning context to enrich writing competence among EFL learners. (Chao & Lo, 2011; Chen et al., 2022). The current research also indicates that engaging in peer-editing activities via platforms like Google Docs significantly improves students' motivation and higher-order thinking skills. This process encourages learners to assess and provide constructive feedback on their peers' written work, fostering critical thinking and analytical skills

essential for academic growth. By participating in these collaborative exercises, students enhance their understanding of the subject matter, improve their ability to communicate effectively, and develop a stronger sense of ownership over their learning.

As facilitated by Google Docs, collaborative writing provides a platform for engaging in a social and interactive writing process. Online environments for cooperative learning enable EFL learners to participate in joint learning and receive peer feedback, thereby enhancing their writing capabilities. (Abe, 2020). By providing immediate feedback, Google Docs encourages the participants in interactive writing processes and may help them expand their linguistic repertoire and sense of flow, allowing for greater coherence and cohesion in their written expression. This notion has been supported by prior research. For example, Alharabi (2020) emphasized the pivotal capacity of web platforms in extending linguistic resources. Similarly, in their study, Ebadi and Rahimi (2019) revealed that employing Google Docs fosters more sophisticated sentence structures, vocabulary, and discourse features, thereby enhancing the complexity of written texts.

Furthermore, the current study demonstrates that Google Docs-based instruction has a positive impact on writing accuracy. This finding aligns with existing literature that supports the benefits of digital spaces in enhancing accuracy through self-correction and error analysis (Link et al., 2022). The editing attributes of Google Docs enable students to identify and rectify errors in authentic situations, promoting accuracy during the writing process. Additionally, the collaborative nature of Google Docs enables students to receive peer and tutor feedback, thereby enhancing their ability to produce more accurate written texts. Hence, the improvement in writing accuracy witnessed in the current survey can be ascribed to the interactive and corrective features of Google Docs. This finding aligns with Ellis's study (2009), which uncovered the importance of feedback and error correction in improving language accuracy.

Furthermore, our findings indicate that Google Docs-based instruction contributes to the development of writing fluency. The significant improvement in fluency scores is consistent with prior research emphasizing the importance of digital environments in promoting writing fluency (Haug & Klein, 2018; Williams & Beam, 2019), which may be because by facilitating authentic collaboration, simultaneous editing, and revision tracking, Google Docs incorporates students into a more fluid and dynamic writing process, bolsters writing flow, and allows for greater coherence and cohesion in their written expression.

Regarding the second research question, as confirmed in the previous research, participants appreciated the ease of collaboration, real-time editing, and visibility of each other's work, which enhanced their writing process. This result may be attributed to the integration of technology, which fostered a heightened sense of active participation and contribution to peers' work, thereby enhancing students' engagement and motivation. (López-Pellisa et al., 2021; Rashid et al., 2019). The findings of the present study align with the work of Su and Zou (2022), who emphasized that participants valued the convenience of authentic collaboration, which enables document access from any location and enhances coordination and teamwork, even amid busy schedules.

Furthermore, the participants' capacity to contribute at their convenience created a more inclusive learning environment. They underscored the importance of peer discussions, which helped them gain insights, explore different perspectives, and improve their writing quality, supporting prior research on the benefits of peer interaction for enhancing writing skills (Bui & Kong, 2019; Fan & Xu, 2020). Additionally, consistent with the results of the current investigation, Andres (2018) confirmed that the participants recognized their initial difficulties in sharing their writing with peers; however, they quickly highlighted the emerging collaborative benefits, such as increased motivation, a sense of belonging, and the opportunity to receive constructive feedback.

Participants appreciated the teacher's guidance and feedback, which fostered a supportive learning environment and facilitated the writing process. This finding is supported by Álvarez et al. (2009) and Cahusac de Caux and Pretorius (2024), highlighting the teacher's role as an expeditor who provides constructive feedback and emotional support to enhance collaborative writing.

6. Conclusion and Implications

The present study affirmed the effectiveness of the Google Docs cooperative writing based on CAF facets. The results underscored that the GD group considerably outperformed the CT group. Quantitative analysis revealed improvements in their writing, and qualitative data revealed positive participant perceptions of the Google Docs approach. Interview themes highlighted the benefits of collaboration, citing convenience and real-time features as key factors. Participants noted that peer mediation was vital for developing their skills, and they acknowledged both the challenges and advantages of collaboration, stressing the indispensable role of tutors as expeditors in the writing process.

This research also highlights key implications for EFL writing instruction with Google Docs. The GD group exhibited striking improvements in writing CAF, demonstrating the tool's effectiveness. Real-time collaboration and peer assessment foster dynamic learning experiences, providing timely feedback. Interviews indicate that participants appreciated the benefits of collaboration and peer feedback. These findings suggest that teachers should incorporate Google Docs-based collaborative writing activities into their instruction to enhance student participation in collaborative writing.

The outcomes highlight the significant impact of peer mediation on writing development, showing that peer assessment through Google Docs enhances writing confidence and achievement. Students take ownership of their learning by actively engaging in the process of peer feedback, which not only promotes their personal growth but also empowers their peers' academic development. Through peer editing, students learn to critically analyze each other's work, offering constructive feedback that highlights strengths and identifies areas for improvement. Hence, the present study's findings can encourage educators to promote collaborative efforts using digital tools,

such as Google Docs, in EFL writing classrooms. While the study yielded positive outcomes, it also identified challenges, including the necessity for clear guidelines on peer assessment, managing group dynamics, and resolving technical issues. These insights can help educators formulate effective strategies, such as providing explicit instructions and support, to maximize the benefits of Google Docs-based writing instruction.

Besides several implications of the study, it has some limitations. The study focused on a specific group of Iranian EFL learners, so caution is warranted when generalizing the findings to other contexts, as cultural and educational differences may impact the effectiveness of Google Docs-based instruction. Additionally, while a mixed-methods design provided a comprehensive view, the small sample size for the qualitative interviews limits the depth of insight into participants' experiences. A larger sample could provide a more thorough understanding of attitudes toward Google Docs-based writing instruction.

The inquiry employed a pretest/posttest design, utilizing Google Docs-based instruction and conventional teaching methods. While this design facilitated group comparisons, it lacked a randomized control trial, which would have enhanced internal validity and reduced the impact of confounding variables. Furthermore, the focus was on writing CAF, neglecting other vital aspects, such as cohesion and coherence. Therefore, other investigations should explore a broader range of writing dimensions to better examine the efficacy of Google Docs on overall writing proficiency. Lastly, the study relied on self-reported information from participants, including interviews and their perceptions of their writing development. While valuable, self-reports are subjective and may be influenced by biases. Combining these with objective measures, like independent writing sample ratings, could strengthen the findings.

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