Exploring Recent Research Methodology on Technology-enhanced Collaborative Writing in EFL Setting: A Systematic Review

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Abstract: Driven by the accelerating infusion of technology into learning scenarios, English as a foreign language (EFL) has been increasingly implemented technology-enhanced collaborative writing (TECW) practice. Nonetheless, updated reviews of studies on TECW are meager. This review aims to uncover and summarize the latest research methodological aspects of TECW by reviewing 71 empirical studies published from 2014 to 2023. The results showed that all the selected studies were conducted in formal education settings, mainly involving higher education students with various sample sizes. The most frequently used designs were mixed-methods, quasi-experimental, and case studies. The studies employed 21 types of technology 71 times. Most studies utilized multiple data collection methods, in which surveys, documentation, tests, and interviews were the most prominent. In terms of data analysis, every study employed 1.8 techniques on average, where descriptive statistics, inferential statistics, and qualitative data analysis were the most frequently used. Based on the results, this review made some recommendations for future studies.

Keywords: Collaborative Writing, EFL, Systematic Review, TECW

1. Introduction

Collaborative writing (CW), defined as producing a single text through the cooperation of two or more writers (Storch, 2019), has gained increasing interest among educators and researchers since the 1980s and is regarded as a more effective alternative approach to teaching writing (Fernández-Dobao, 2020). Two driving factors of the growing interest have been identified: (1) writing in various organizations is completed in teams, not individually, and (2) literary practices transformation stimulated by Web 2.0 advancement have made text production and sharing easier and more willingly accepted (Storch, 2019). Supported by cognitive and socio-cognitive theories, and reinforced by communicative language teaching and task-based language teaching principles, CW instruction emphasizes the essence of assigning learners to actively collaborate in pairs or small groups when practicing producing a single text. Their collaboration during the learning process gives them more opportunities to engage, reflect, solve language problems, seek information, and share ideas (Aldoayan et al., 2019; Dao, 2020).

The exponential growth of technology and its infusion into learning scenarios have not only driven CW but have also made technology an integral part (Rosales et al., 2020) for several reasons.

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First, technology-enhanced instruction supported students' composing processes and skills for the prevalent accessibility of technology-mediated writing platforms and editing has expanded collaboration ranges, opportunities, and patterns and enabled new interaction forms. The affordance of highly interactive synchronous, asynchronous, and multi-way communication tools, for instance, can greatly contribute CW instructions. Second, time limitations and other administrative constraints that frequently challenge the traditional face-to-face writing classes can be overcome by technology use (Ebadi & Rahimi, 2018). Technology-enhanced peer interactions can also be more comfortable than face-to-face interactions because learners are provided sufficient time and non-threatening environments (Al-Jarf, 2005). Third, technology integration encouraged student engagement and participation in writing projects and increased their social and peer collaboration (Williams & Beam, 2019). Fourth, the promotion of social collaboration in the digital environment by technological interactive tools has encouraged writing as a social activity, leading to a growing interest in implementing technology-enhanced collaborative writing instruction (Godwin-Jones, 2018). Finally, technology eases teachers to provide feedback, evaluate, and even trace students' CW processes (Elola & Oskoz, 2017).

The high interest in integrating technology in CW instruction has emerged technology-enhanced collaborative writing (henceforth, TECW) as a new branch of technology-enhanced language learning (henceforth, TELL), which is defined as the infusing or making technology an integral element of the learning environment to complement teaching methods for facilitating language acquisition and use (Walker & White, 2013). TELL includes any digital technology use to promote both language learners' and teachers' educational undertakings in any form of language learning (Al-Yafaei & Mudhsh, 2023), while TECW focuses only on the integration of digital technologies in CW instruction (Li, 2018; Storch, 2019). Numerous studies have revealed some advantages of TELL implementation, among others: technology facilitates learners to interact with the real world, enhances their language skills, and increases their learning performance (Persson & Nouri, 2018), most language learners perceived technology integration into learning positively (Shadiev et al., 2017), and technology integrated instruction might generate better impacts than non-technology language teaching (Chang & Hung, 2019).

Since TELL has been proven to provide various benefits and positive impacts, as its branch, TECW is believed to have a promising potential to help second/foreign language learners improve their writing quality. The promising potential has not only impelled TECW to gain growing interest in second/foreign language settings (Zhang et al., 2021) but has also shifted research on CW from the traditional pen-and-paper method to a multi-modal technology-enhanced mode (Li & Storch, 2017). This is shown by the substantial expansion of TECW research in recent years (Coyle et al., 2018; Zou et al., 2019).

Due to such research expansion, it is necessary to conduct a systematic review of the literature to inform researchers of the state of the art in this field. Some reviews on technology use in writing instruction are available in the literature. Alkhataba et al. (2016) analyzed 48 studies to explore the most capable Webs 2.0 technologies for online CW and found Edmodo, Google Docs, Wikis, Zoho, Blogs, and Facebook as the potential technologies. Reviewing 17 studies published between 2000 and 2015, Yim and Warschauer (2017) found that the frameworks applied in TECW included socio-constructivist (40%), socio-cultural theory 24%, and unspecified (34%). Most of the studies were set in English as a second language (ESL) contexts, involving students of higher education (82%) and secondary school students (18%), and focusing

on the strands of the CW process, learning outcomes, and perceptions of CW. The results also showed that the prominent research designs were respectively qualitative, descriptive qualitative, and quasi-experimental. In another study, Li (2018) reviewed 21 research on technology-mediated CW published from 2008 to 2017. She found that most studies were set in ESL contexts, and applied socio-cultural theory as the most frequent framework. She also found that Google Docs, Wikis, and Chat were the most frequently used technologies, and the major research foci were the writing process, interaction, students' perceptions, and outcomes or products.

Since these studies included research published up to 2017, the latest progress and newest situations in this field may left uncovered because the rapid advancement of technology could have made the innovative tools before 2017 unfashionable today (Shadiev & Yang, 2020). Moreover, these studies included research predominantly set in ESL contexts. Thus, TECW research in English as a foreign language (EFL) setting remained uncovered. ESL and EFL learning are different in various aspects. Unlike ESL learners who are usually surrounded by English and have urgent needs to write in English as they are studying in an English-speaking environment, EFL learners have limited exposure and opportunities to use English and might have no clear direct purposes for writing in English (Reichelt, 2013). Research results on TECW in ESL settings, therefore, do not necessarily apply to EFL instructions. Conducting a timely review of recent TECW research in EFL settings was, therefore, useful, and, to the present writer's knowledge, a systematic review of research on TECW in the EFL setting is unavailable. This paper was an attempt to fill in the gap.

This paper is the second part of a systematic review of the empirical research on TECW in EFL settings published in 2014–2023 conducted to explore the research features and development tendency in this area. The first part (Pardede, 2024) focused on the strands and findings of the selected studies, while this paper focused on various methodological aspects. Yet, the first part included only 45 studies, while this second part covered 71 studies because, after publishing the first part, the author attempted another search and managed to select 26 additional studies. Accordingly, this paper aims to address the following question: What is the current state of TECW in terms of research design, types of technologies, participants, data collection methods, and data analysis methods?

2. Methodology

I administered the three-step process—search, evaluation, and data finalization—employed by Zou et al. (2019) to systematically search and select the studies in this review twice, in January and May 2024. Google Scholar was selected as the database because, since its inception in 2004, it continuously expands and has now far surpassed other scientific literature databases in terms of the number of documents covered (Halevi et al., 2017).

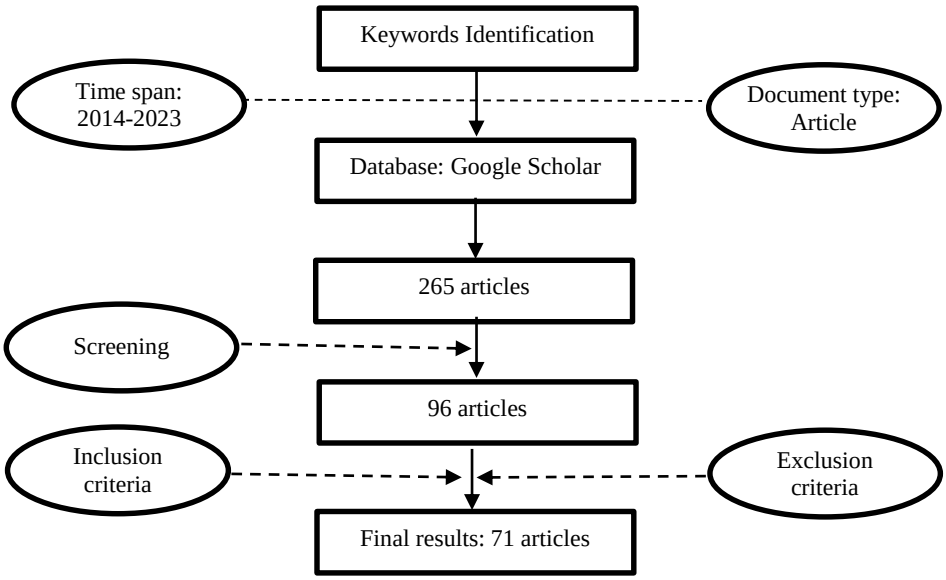

Figure 1: The data search, selection, and collection process and methods

As described in Figure 1, the search employed the combination of keywords 'technology-enhanced collaborative writing', online collaborative writing', 'technology-mediated collaborative writing', 'and 'EFL' and 2014 to 2023 as the time frame. Then, I screened the articles based on titles and abstracts. Next, I narrowed them down for inclusion using the inclusion and exclusion criteria listed in Table 1. Non-empirical research articles (e.g. review and synthesis articles) were excluded because such articles do not involve primary data collection, whereas this review focuses on research methodological aspects.

Table 1: Inclusion and Exclusion Criteria

Inclusion Criteria	**Exclusion criteria**
Empirical research articles	Thesis, dissertation, review/synthesis article
study CW using Web 2.0 tools	Non-CW or face-to-face CW practices
Published in established peer-reviewed journals and proceedings related to ELT	Published in non-peer-reviewed journals
Published between 2014 and 2023	Published before 2014
Written in English	Text not written in English
Indexed in Google Scholar sites	Unindexed in Google Scholar sites

The data obtained from the 71 articles was analyzed qualitatively using the constant comparative method, which unites systematic data collection, coding, and analysis with theoretical sampling to generate a theory that is integrated, close to the data, and declared in a clear form for further testing (Conrad et al., 1993, as cited in Kolb, 2012). In this paper, I employed the method in four steps. First, I examined the first selected study. Second, I registered its content to create a preliminary theme. Third, I assessed the second study. Fourth, I compared the second study to the first study's themes. If the articles' themes are alike, the third paper was scrutinized. But if both articles are alike in one theme but vary in sub-themes, new sub-themes are created. For instance, in terms of data collection methods, both the first and second papers in this study

employed surveys. So, both were placed under the same sub-theme of data collection methods. If the themes of the first and second articles were dissimilar, another theme was made. For instance, in terms of research participants, the first paper involved higher education students, while the second involved English teachers. Therefore, a new sub-theme called English teachers was created under the theme of research participants to accommodate the second paper. Then, the review continued by evaluating the next study and comparing it to the previous ones. Thus, every article was scrutinized and associated with another. Through constant comparison, the current state of TECW in terms of research design, types of technologies, participants, data collection methods, and data analysis methods could hopefully be explored comprehensively.

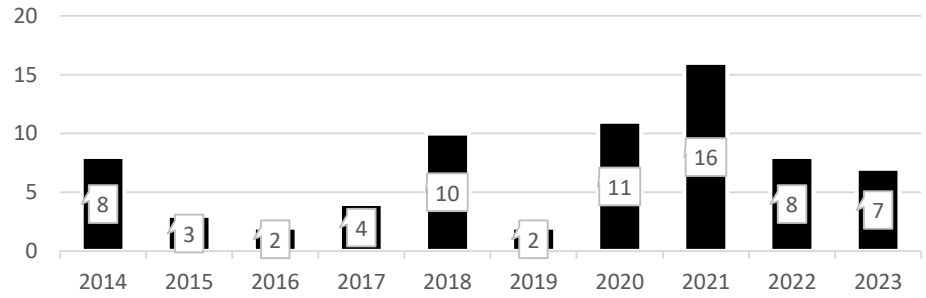

Figure 2: Articles Distribution by Year of Publication

3. Findings

Employing the three-step process and inclusion and exclusion criteria, 71 articles were selected. Figure 2 displays the articles' distribution by publication year. Since 42 (59%) articles were published in the last four years, research interest in the TECW area seems to be currently increasing.

3.1 Research Methods and Designs

In terms of research methods, as shown in Table 2, quantitative research was the most dominant, followed by mixed methods research, qualitative research, and action research. Employed in 28 out of the total 71 studies (30%), the quantitative method consisted of 23 quasi-experimental designs, 1 correlational design, and 4 survey designs. Mixed methods were used in 23 (32%) of the selected studies. Qualitative methods, consisting of case studies and descriptive designs, were used in 17 (23%), and action research was used in 3 (4.2%) of the studies.

Table 2: Research Methods and Designs Distribution by Publication Periods

Publ. Year	Quantitative			Qualitative		Mixed-methods	Action Research	Total
	Experiment	Correlat-ional	Survey	Case Study	Descriptive Qualitative			
2014-15	3 (4.2%)	0	1 (1.4%)	2 (2.8%)	2 (2.8%)	3 (4.2%)	0	11 (15.5%)
2016-17	0	0	0	1 (1.4%)	1 (1.4%)	3 (4.2%)	1 (1.4%)	6 (8.4%)
2018-19	5 (7%)	0	0	3 (4.2%)	0	3 (4.2%)	1 (1.4%)	12 (16.0%)
2020-21	9 (12.7%)	0	2 (2.8%)	5 (7%)	1 (1.4%)	10 (14%)	0	27 (38%)
2022-23	6 (8.4%)	1 (1.4%)	1 (1.4%)	1 (1.4%)	1 (1.4%)	4 (5.6%)	1 (1.4%)	15 (21.1%)
Total	23 (32%)	1 (1.4%)	4 (5.6%)	12 (16.0%)	5 (7%)	23 (32%)	3 (4.2%)	71 (100%)

Regarding the research designs, mixed-methods, quasi-experimental, and case studies were the top three designs. Each of the mixed-methods and quasi-experimental designs was used in 32%, while case study was identified in 12% of the selected studies. Despite its having an equal frequency in use with the quasi-experimental design, mixed methods were the most consistently employed. It was used in at least one study in every publication period, while the quasi-experimental design was absent in 2016-2017.

In terms of types, the selected experimental research included pre-experimental and quasi-experimental. The pre-experimental covered one-shot case study design (e.g., Moonma, 2021), one-group pre-post-test design (Ahmad, 2020; Liu et al., 2022), and intact-group comparison design (e, g. Ren et al., 2022). The quasi-experimental design included time series design (e.g., Fathi et al., 2021; Kılınç & Yüksel, 2024) and non-equivalent control group design (e.g., Arifani et al., 2020; Liu et al., 2022).

3.2 Sample (Participants)

The studies were set in formal education and most (81%) of them involved university students as the principal subjects of inquiry (Table 3). Only 14% of the studies involved secondary school students, 4.2% involved English teachers, and 1.4% involved elementary school students. The findings also showed that TECW implementation in secondary and elementary education just began to catch researchers' attention starting from 2018-2019 onwards.

Table 3: Research Participants Distribution by Publication Periods

Edu. Levels	**2014-2015**	**2016-2017**	**2018-2019**	**2020-2021**	**2022-2023**	**Total**
Elementary School Ss	0	0	0	1 (1.4%)	0	1 (1.4%)
Sec. School Ss	0	0	2 (2.8%)	6 (8.4%)	2 (2.8%)	10 (14%)
HE Ss	11 (15.4%)	6 (8.4%)	11 (15.4%)	16 (22.4%)	13 (18.2%)	57 (81.4%)
English Teachers	0	0	0	3 (4.2%)	0	3 (4.2%)
Total	11 (15.4%)	6 (8.4%)	13 (18.2%)	26 (36.2%)	15 (21%)	71 (100%)

In terms of sample sizes, using the classification proposed by Hwang and Fu (2019), Table 4 shows that the majority of the selected studies adopted two types of sample sizes: small and medium. Both were equally adopted by 32.4% of the studies. The small sample size was adopted by almost all research designs, except correlational study, while the medium sample size was not adopted by correlational study and action research. The medium to large sample size was used by 25.3% of the studies. No correlation and case study adopted this sample size. The large sample size was used only in 9.8% of the studies. It was adopted by studies with mixed methods, experimental correlation, and action research designs.

Table 4: Participants Size by Sample Sizes

***Sample Sizes**	**Quantitative**			**Qualitative**		**Mixed-methods**	**Action Research**	**Total**
	Exprmnt	**Correlation**	**Survey**	**Case Study**	**Descrpt.**			
Small	5 (7%)	0	1 (1.4%)	6 (8.4%)	3 (4.2%)	7 (9.8%)	1 (1.4%)	23 (32.4%)
Medium	6 (8.4%)	0	2 (2.8%)	6 (8.4%)	1 (1.4%)	8 (11.3%)	0	23 (32.4%)
Medium to Large	10 (14%)	0	1 (1.4%)	0	1 (1.4%)	5 (7%)	1 (1.4%)	18 (25.3%)
Large	2 (2.8%)	1 (1.4%)	0	0	0	3 (4.2%)	1 (1.4%)	7 (9.8 %)
Total	23 (32.4%)	1 (1.4%)	4 (5.6%)	12 (16.9%)	5 (7%)	23 (32.4%)	3 (4.2%)	71 (100%)
Small: <30 Medium: 30-50 Medium to Large: 50-100 Large: > 100								

3.3 Data Collection Methods

Table 5 shows the total number of methods used in the 71 studies was 116. That means every study employed 1.6 methods on average, indicating that many of the selected studies utilized multiple data collection methods. The most frequently employed data collection methods were respectively surveys, documentation, tests, and interviews. Little research employed the observation method. The survey method included offline and online surveys. The documentation method included online artifacts, writing portfolios/tasks, chats, feedback practices, online discourses, and reflective journals. The tests included formative writing assignments (e.g., Zhang et al., 2014) summative writing assessments (e.g., Arifani et al., 2020; Bui & Vu, 2023), or the combination of both (e.g. Çelik & Aydin, 2021). The interview method included semi-structured interviews (e.g., in Jong & Tan, 2021; Yeh & Chen, 2019) and focus group

interviews, which belong to semi-structured interviews, (e.g., Aydin & Yildiz, 2014; Selcuk et al., 2019), No study administered a structured interview, and unstructured interview.

Table 5: Data Collection Methods Distribution by Publication Periods

Methods	**2014-2015**	**2016-2017**	**2018-2019l**	**2020-2021**	**2022-2023**	**Total**
Surveys	8 (6.9%)	3 (2.6%)	4 (3.4%)	12 (10.3%)	10 (8.6%)	37 (31.9)
Documentation	5 (4.3%)	3 (2.6%)	5 (4.3%)	13 (11.2%)	2 (1.7%)	28 (24.1%)
Interviews	3 (2.6%)	4 (3.4%)	4 (3.4%)	9 (7.7%)	3 (2.6%)	23 (19.8%)
Tests	3 (2.6%)	2 (1.7%)	4 (3.4%)	10 (8.6%)	5 (4.3%)	24 (20.6%)
Observations	0	0	1 (0.8%)	3 (2.6%)	0	4 (3.4%)
Total	19 (16.3%)	12 (10.3%)	18 (15.5%)	47 (40.5)	20 (17.2%)	116 (100%)

3.4 Data Analysis Techniques

As shown in Table 6, the total number of techniques used in the 71 studies on TECW in EFL settings published in the 2014 to 2023 period was 125. This means every study employed 1.8 techniques on average. Although some studies used only one technique (e.g. Alghammas, 2020; Ali & Sarok, 2022), many others employed multiple techniques (e.g., Bui & Vu, 2023; Farahian & Ebadi, 2022). The most frequently employed data analysis techniques were descriptive statistics (43.2%), with inferential statistics (28.8%) in the second place, and qualitative data analysis (QDA) in the third place (28%).

Table 6: Data Analysis Techniques Distribution by Publication Periods

Techniques	**2014-2015**	**2016-2017**	**2018-2019l**	**2020-2021**	**2022-2023**	**Total**
Descriptive statistics	10 (8%)	5 (4%)	10 (8%)	17 (13.6%)	12 (9.6%)	54 (43.2%)
Inferential statistics	5 (4%)	4 (3.2%)	6 (4.8%)	13 (10.4%)	8 (6.4^)	36 (28.8%)
Qualitative Data Analysis	6 (4.8%)	3 (2.4%)	4 (3.2%)	12 (9.6%)	10 (8%)	35 (28%)
Total	21 (16.8%)	12 (9.6%)	20 (16%)	42 (33.6%)	30 (24%)	125 (100%)

The QDA was adopted using various techniques. Table 7 shows that the top three techniques were content analysis (37.5%), thematic analysis (36.5%), and text mining (5.7%) respectively. The prominent use of content analysis, thematic analysis, and text mining are probably due to their systematicity, or provision of a structured way to identify and classify patterns or themes within the data, and flexibility and adaptability to various types of data (Humble & Mozelius, 2022).

Table 7: Qualitative Data Analysis Techniques Distribution by Publication Periods

QDA Techniques	**2014-2015**	**2016-2017**	**2018-2019l**	**2020-2021**	**2022-2023**	**Total**
Content Analysis	3 (8.6%)	2 (5.7%)	2 (5.7%)	5 (14.3%)	4 (11.4%)	16 (45.7%)
Thematic Analysis	3 (5.7%)	1 (2.85%)	2 (5.7%)	4 (11.4%)	3 (5.7%)	13 (37.1%)
Text mining	0	0	0	1 (2.85%)	1 (2.85%)	2 (5.7%)
Dyadic interaction	0	0	0	0	1 (2.85%)	1 (2.85%)
Correspondence analysis	0	0	0	1 (2.85%)	0	1 (2.85%)
Open Coding Analysis	0	0	0	1 (2.85%)	0	1 (2.85%)
Lexical-semantic	0	0	0	0	1 (2.85%)	1 (2.85%)
Total	6 (17.15%)	3 (8.6%)	4 (11.4%)	12 (34.3%)	10 (28.6%)	35 100%)

Table 7 shows that each of dyadic interaction, correspondence analysis, open coding, and lexical-semantic analysis techniques was used only once. Although they are more specific, relatively complex, and necessitate more time and resources to conduct than the more common techniques, they can provide richer, deeper, and more understanding of qualitative data. Dyadic interaction analysis, for instance, can facilitate deeper analysis of interview data (Collaço et al., 2021). Correspondence analysis assists in exploring large datasets and in visualizing the relationships of categorical variables (Habib et al., 2012). Lexical semantic analysis can help disclose hidden patterns and themes in textual data (Pustejovsky et al., 1993). Therefore, their underuse in the reviewed papers may reduce the richness and depth of the findings.

3.5 Types of Technologies

Table 8 shows that 66 of the reviewed studies employed 21 types of technology, and 5 studies did not specify the technology they used. Since the total number of technologies identified in the 71 studies was 76, every study employed 1.07 technologies on average, indicating that some of the studies employed more than one technology. Brodahl and Hansen (2014), for instance, used Google Docs and EtherPad to compare students' preferences in using them in CW practices. Cho (2017) combined Google Docs and Skype to enable students to communicate verbally through voice chat while writing collaboratively.

Table 8: Technology Types and Their Use Distribution by Publication Periods

***Technology**	**2014-2015**	**2016-2017**	**2018-2019l**	**2020-2021**	**2022-2023**	**Total**
Blog	1 (1.3%)	0	1 (1.3%)	0	0	2 (2.6%)
CollaWrite	0	0	0	0	1 (1.3%)	1 (1.3%)
Cooperpad	0	0	1 (1.3%)	0	0	1 (1.3%)
Ebeam	0	0	0	1 (1.3%)	0	1 (1.3%)
Edmodo	0	0	0	0	1 (1.3%)	1 (1.3%)
EtherPad	2 (2.6%)	0	0	0	0	2 (2.6%)
Facebook	3 (3.9%)	1 (1.3%)	0	1 (1.3%)	0	5 (6.6%)
FlipGrid App	0	0	0	0	2 (2.6%)	2 (2.6%)

Forum	1 (1.3%)	0	0	0	0	1 (1.3%)
Google Docs	1 (1.3%)	3 (3.9%)	5 (6.8%)	6 (7.9%)	7 (9.5%)	22 (28.9%)
Messenger	0	0	1 (1.3%)	0	0	1 (1.3%)
Padlet	0	0	1 (1.3%)	2 (2.6%)	1 (1.3%)	4 (5.2%)
MSW Doc	1 (1.3%)	1 (1.3%)	0	0	0	2 (2.6%)
Quip	0	0	0	1 (1.3%)	0	1 (1.3%)
Schoology	0	0	0	1 (1.3%)	0	1 (1.3%)
Skype	0	1 (1.3%)	0	0	0	1 (1.3%)
Telegram	0	0	2 (2.7%)	1 (1.3%)	0	3 (3.9%)
WeChat	0	0	0	1 (1.3%)	0	1 (1.3%)
WhatsApp	0	0	2 (2.6%)	1 (1.3%)	1 (1.3%)	4 (5.2%)
Wikis	3 (3.9%)	1 (1.3%)	2 (2.6%)	4 (5.2%)	3 (3.9%)	13 (17.1%)
Zoom	0	0	1 (1.3%)	1 (1.3%)	0	2 (2.6%)
Unspecified	0	0	1 (1.3%)	4 (5.2%)	0	5 (6.6%)
Total	12 (15.8%)	7 (9.2%)	17 (22.4%)	24 (31.6%)	16 (21.1%)	76 (100%)

**Some studies employed more than one technology*

Additionally, the most frequently and consistently used technologies were Google Docs (28.9%) and Wikis (17.1%). The next popular but less frequently used tools were Facebook Group (6.6%), WhatsApp (5.2%), and Padlet (5.2%).

4. Discussion

4.1 Research Methods and Designs

The finding that mixed-methods, quasi-experimental, and case study were the top three research designs in the selected studies conform to the finding that recent research on TECW focuses on three main foci—writing process, learning outcomes, and students' and teachers' perceptions and attitudes (Pardede, 2024) because these three research designs befit to investigate these foci. Mixed methods and quasi-experimental are suitable for researching learning outcomes, while case studies and mixed-methods are proper for exploring the writing process and perceptions/attitudes.

The selected studies employed mixed methods designs most frequently and consistently. This might be due to its potential to help the researchers understand the different interpretations of a certain phenomenon. Using a mixed methods design to study a new instructional practice such as TECW is advantageous because its integration of the qualitative and quantitative research components empowers it to provide broad and strong conclusions. Employing this design, Hosseini et al. (2020) investigate the effect of Wikis on learners' writing fluency, and their attitudes toward using Wikis in CW instruction, and Miftah and Cahyono (2022) explored students' attitudes and engagement in TECW practice.

In the selected studies in this review, quasi-experimental design was appropriately adopted to measure the effect of certain aspects of TECW implementation on participants' writing performances (e.g., Ahmad, 2020; Entezari & Taki, 2018) and/or other outcomes, such as perceptions and attitudes (Liu et al., 2022), and motivation (Çelik & Aydin, 2021) before and after participating in the TECW learning activities. In

terms of types, the experimental research included pre-experimental and quasi-experimental. A true experimental design was never adopted, probably due to the well-known practical obstacles to random assignment of learners to groups.

A case study is one of the most appropriate research designs to explore a contemporary phenomenon or a novel practice such as TECW in a natural context. It can effectively provide a better understanding of learners' and teachers' experiences, issues, insights, developmental pathways, or performance. That's why it became one of the major designs in this review. Selcuk et al. (2019), for instance, conducted a case study to explore the factors that lead group members to choose their group leader in CW work group and how group leaders influence their group members during the collaborative process. Kitjaroonchai and Loo's (2023) case study explored group interaction patterns and the factors affecting learners' active and inactive participation in TECW.

The two most unpopular research designs in the selected studies were correlational (used only by 1.4%) and action research (4.2%). Their infrequent use was most likely due to the need for the researchers to have a clear picture of the variables to correlate (in correlational research) or to components to use as an intervention (in action research). Yet, the researchers' familiarity with TECW variables was still limited due to the newness of the practice.

4.2 Sample (Participants)

There are two possible reasons why 81% of the reviewed studies involved students within higher education as the participants. First, the researchers were lecturers, to whom university students were these students most accessible. To avoid technical and administrative constraints, they decided to involve them as their research participants. Second, university students attracted the researchers' attention as they were supposed to be able to learn to write collaboratively using technology much more easily than the younger students (Shadiev et al., 2017). Additionally, the finding that TECW implementation in secondary and elementary education began to catch researchers' attention in the 2018-2019 and 2020–2021 periods indicated that the recognition of TECW in EFL settings has recently expanded to a larger group of people, including younger learners.

The findings indicated that sample sizes were mainly dependent on the research designs employed. Case studies and descriptive qualitative research predominantly adopted small sample sizes (e.g., Cho, 2017; Saeed & Ghazali, 2017) and medium sample sizes (e.g., Zakaria et al., 2023). Many of the quantitative and mixed methods studies adopted medium to large sample sizes (e.g., Jiang & Zhang, 2020) and large sample sizes (e.g., Liu et al., 2018). The sample sizes in the selected qualitative studies were generally appropriate. In qualitative studies, whose aims are to unravel the study phenomenon under investigation profoundly, 3 to 5 participants, for instance, can be appropriate for a case study (Creswell, 2018). In quantitative studies, research conducted to test a new instruction approach typically requires 24 participants per group (control and experimental), while a simulation-based educational study requires a median sample size of 30 (Besekar et al., 2024). Therefore, the quantitative studies in this review qualify, because 54% of the quasi-experimental, correlational, and survey studies adopted medium to large and large sample sizes, while the rest adopted small and medium sample sizes.

Additionally, quantitative studies' samples should be selected using the probability sampling technique to ensure generalization to the target population. Some quantitative studies in this review did use probability sampling techniques, such as cluster sampling (e.g. Suwantarathip & Wichadee, 2014) and simple random (e.g. Jiang & Zhang, 2020), but the others used non-probability sampling techniques, such as convenience sampling (e.g. Ahmad, 2020) and purposive sampling (e.g. Entezari & Taki, 2018). Therefore, these studies can be replicated using probability sampling in the future.

A majority (65%) of mixed methods studies in this review adopted small and medium sample sizes, while the rests used large and large sample sizes. To enhance the inference quality, Onwuegbuzie and Collins (2017) suggested mixed methods researchers to mind the six sampling considerations, namely emic orientation, probabilistic orientation, abductive orientation, intrinsic versus instrumental orientation, particularistic versus universalistic orientation, and philosophical clarity at the stages of research conceptualization, research planning, research implementation, and research dissemination.

4.3 Data Collection Methods

The finding that survey was the most frequently used data collection method among the selected studies might be due to the possibility of using it for gathering either qualitative and quantitative data or both. Since surveys are appropriate to gather information about the respondents' opinions, behavior, or knowledge concerning a service, product, or process, and many of the selected studies focused on the writing process, group collaboration dynamic, and participants' perceptions and attitudes foci, surveys befitted them. Additionally, surveys could be conducted via telephone, mail, or the Internet, as well as in person using physical or digital questionnaires. Many surveys in the selected studies used online questionnaires created with the Drupal module (e.g., Brodahl & Hansen, 2014), or Google Form (Ali & Sarok 2022). Others (e.g., Ambrose & Palpanathan, 2018) distributed printed questionnaires, while some others (e.g., Jong & Tan, 2021) combined the online and offline surveys.

Documentation was the second prominent data collection method in the selected studies because of two main reasons. First, documentation can be effectively employed in TECW research as it facilitates the collection and analysis of documents (both written and electronic) and visual materials, such as images, video, and film as well. Studies in this review adopted the documentation method by collecting and analyzing various types of electronic documents such as participants' writing tasks (Rahimi & Fathi, 2021), blog-based peer comments (Xu & Yu, 2018), records of students' online discourses in Google Docs (Yeh & Chen, 2019), and participants' transcripts of text-based collaborative dialogues and writing process logs (Yeh, 2014). Second, documentation could be used as an independent method or in combination with other methods as a triangulation means. In this review, three out of five descriptive qualitative studies used documentation as an independent data collection method (i.e., Abe, 2020; Razak & Saeed, 2014; Saeed & Ghazali, 2017). Many other studies, especially those using case studies and mixed-methods (e.g., Aydin & Yildiz, 2014; Hosseini et al., 2020), administered documentation in combination with one or more other methods.

4.4 Data Analysis Techniques

There are two reasons why many of the selected studies adopted multiple data analysis techniques. First, almost one-third of the studies used mixed methods designs, which require more than one technique to analyze the collected quantitative and qualitative data. Second, every analysis in the experimental research administered descriptive statistics before using inferential statistics.

Descriptive statistics was the most frequently used analysis technique because all the experimental and correlational research in this review administered descriptive statistics to present the data for setting the scene for the hypothesis testing necessitated to infer causation or relation among variables. Most survey research, mixed-methods, case studies, and action research also employed descriptive statistics to describe the data through various representative methods using tables, charts, and figures to make it easily understood.

Various inferential statistics, both parametric and non-parametric tests were used in all experimental research and some mixed methods studies, depending on their objectives. Some researchers (e.g., Yeh, 2014) administered parametric tests (e.g., paired and unpaired t-tests and ANOVA. Some others (e.g., Ahmad, 2020) administered non-parametric tests (e.g., Mann–Whitney U test, Friedman test, and Wilcoxon signed-rank test). Such use of various inferential statistics indicated the complexity of the data tested in selected studies. Having data belonged to two groups with a normal distribution, the researchers ran t-tests. However, when the data belonged to three or more groups, ANOVA was used, and when the data did not follow a normal distribution, the researchers ran non-parametric tests.

Qualitative data analysis (QDA) was used in 28% of the selected studies, indicating this technique was essential to achieve the aims of recent research on TECW in EFL settings. QDA is very suitable for organizing, analyzing, and interpreting non-numeric information obtained from linguistic (or visual) materials (including text documents, interview transcripts, user feedback, notes, audio and video recordings, and images (Flick, 2014). Thus, it is befitted for getting a deeper understanding of a new practice like TECW in EFL settings.

Content analysis (CA) became the most prominent probably due to the possibility of using it to combine quantitative and qualitative procedures for getting insights from the complex digital texts in the studies. Kitjaroonchai and Suppasetseree (2021), for instance, used CA to analyze the students' CW process logs in Google Docs through coding, categorizing, and organizing the emerging themes. The second prominent QDA technique was thematic analysis (TA). It assists the researchers to identify repeated patterns or themes in qualitative data by underlining, scrutinizing, and recording patterns, categories, or themes, within data. It also facilitates a more profound analysis, or immersion, by bringing a fuller interpretation of the investigated phenomenon (Humble & Mozelius, 2022). For instance, Özdemir (2021) used TA to scrutinize the students' written texts and the transcriptions of the videos of their writing activities and audio of their group interview records for analyzing the differences between students' CW activities on the Padlet website and in a face-to-face environment,

Text mining (TM) is the third prominently used QDA in the selected papers. Often called "automatic content analysis", TM is the process of extracting useful information from unstructured written data such

as chat messages, text files, emails, and HTML files to discover useful trends, rules, patterns, or models (Feldman & Sanger, 2007). Accelerating QDA processes by reducing the time and resources needed to process qualitative data, TM can be very advantageous for qualitative researchers (Roberts et al., 2014). Among the selected studies, Yeh (2021) analyzed the students' revision histories, text-chat, and written texts using two TM tools, DocuViz and AuthorViz to examine their patterns of interaction and collaboration-related behaviors while writing collaboratively in Google Docs.

Besides CA, TA, and TM, the selected research also employed other four QDA techniques: dyadic interaction (DI), correspondence analysis (CorA), open coding (OC), and lexical-semantic analysis (LSA). Unlike CA, TA, and TM which are more systematic, practical, flexible, and adaptable to various types of data (Humble & Mozelius, 2022), these four techniques are more specialized and complex. They are specialized because they may be appropriate only for few qualitative data types or research questions and complex because they often require substantial resources, such as advanced statistical skills and computational tools (Collaço et al., 2021; Habib et al., 2012; Pustejovsky et al., 1993). Their specificity and complexity are probably the reason why they were underused in the selected studies.

Such underuse can be disadvantageous to the results of the selected studies. Since CA, TA, and TM analysis heavily rely on subjective interpretation of data, they have limitations in catching nuanced emotions and contexts and individual bias could influence the findings (Humble & Mozelius, 2022). Unlike them, DI, CorA, OC, and LSA can provide a richer and deeper understanding and unique insights of qualitative data (Collaço et al., 2021; Habib et al., 2012; Pustejovsky et al., 1993). Therefore, to enrich the depth and credibility of future TECW studies, triangulating dyadic interaction, correspondence analysis, open coding, or lexical-semantic analysis with CA, TA, and TM is recommended.

4.5 Types of Technologies

The finding that Google Docs and Wikis were the two prominent technologies in the selected studies supports Alkhataba et al.'s (2016) finding that Google Docs and Wikis were major useful Web 2.0 technologies for facilitating collaborative online writing. The prominence of Google Docs and Wiki in the selected studies was possibly due to three reasons. First, they are user-friendly and offer convenience for writing, revising, and interacting with peers, and user-friendliness to students (Abrams, 2019; Wang, 2015). Second, they support multimedia technologies integration into collaborative writing. Third, they are useful to researchers and educators because they facilitate automatic saving, organizing, and analysis of historical records of the CW process. Third, they afford group setting and assist feedback giving (Abrams, 2019; Wang, 2015).

Numerous TECW studies in ESL settings have found Google Docs and Wikis as the most frequently used apps. Their prominence indicates the continuous efficacy and technical maturity of these tools in supporting second language CW activities (Li, 2018; Storch, 2019). Regarding this, future TECW research in EFL can investigate how to make them effective to facilitate EFL learners to enhance their writing performance.

Facebook was the third most prominent technology in the selected studies. Its nature as a social networking website, where users can generate, share, and exchange information by posting, liking, and reposting

comments, messages, images, and posting links to news or other interesting content on the web, enables Facebook to facilitate group interactions and information sharing. However, Facebook is not effective for writing long texts collaboratively. Therefore, it should be used as a medium for learners to interact and share information while they are working on text through other apps, such as wikis (Razak & Saeed, 2014).

Although only four of the selected studies used WhatsApp, it was consistently employed in the last three periods of publication, indicating that researchers have just begun to see its potential to complement CW writing activities in EFL settings. The selected studies used it as an additional tool for enhancing collaboration by utilizing the text and voice-based media available in it. For example, Ebadi and Bashir (2021) used WhatsApp to interact with students who were writing collaboratively using Google Docs. The results showed that the group using text-based mediation outperformed the group with voice-based mediation and the group learning without WhatsApp.

5. Conclusions

Since TECW is a relatively new practice in EFL settings, its implementation naturally exposes the learners and teachers to various challenges. To meet these challenges, the selected studies tried to investigate the activities and tasks, collaborative strategies, forms and patterns, learners' group behaviors, awareness, roles and responsibilities, and effectiveness and supporting factors of technology use in TECW in EFL settings. To attain research aims related to these focuses, the selected studies in this review employed various research designs, used several data collection methods and instruments, and adopted numerous data analysis techniques. Since these aspects were appropriate in terms of methodology, to a higher extent, the research results could be regarded as having appropriate explanatory powers.

The sample size of the selected studies, in general, befitted the research designs and objectives. Yet, the predominant involvement of students of higher education as the participants in 81% of the studies caused insights for TECW implementation to students of lower educational levels to be very little. Additionally, the research involving teachers was too little, so we could get only very little understanding of what and how teachers should facilitate students' interactions in TECW. Thus, more future studies are recommended to involve students of primary and secondary schools and teachers as well. Future research is also recommended to involve the newest technology in TECW because technology advances rapidly and newer technology adaptation into TECW can increase its effectiveness. The results of studies involving the newest technology will provide significant evidence of its effectiveness in facilitating TECW.

Finally, due to the great variety of EFL learning and teaching contexts, studies' findings conducted in EFL settings are rarely, if ever, conclusive. Thus, we need further related evidence, which may come from a close replication. Employing meta-analysis, such evidence could increase the precision of the insights that can help instructors implement effective TECW activities, which, in turn, enhance learning outcomes. Therefore, future studies are also recommended to replicate the selected studies in this review.

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