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Implementing technology-enhanced collaborative writing in second and foreign language learning: A review of practices, technology and challenges

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Abstract

Technology-enhanced collaborative writing (TECW) for second language development is receiving increasing research attention from educators and teachers. However, there have been few review studies investigating how teachers implement this activity, how they use technology for the implementation, and what challenges they have. To better prepare practitioners to use digital tools for collaborative writing among their students, we reviewed 42 relevant studies focusing on their implementation identifying nine main TECW practices. These include: receiving teacher training; grouping students; training students on collaboration; training students on technology; providing students with new knowledge of writing; monitoring processes and giving immediate help; providing sufficient autonomy to students; evaluating outcomes and giving feedback; and encouraging students' reflection. Technology could support TECW implementation by expediting information delivery, developing group workspaces and group chatrooms, recording students' writing and collaboration behaviours and visualising their thoughts, enabling teacher commentary and information post, and presenting organised, analysed records of the TECW process. Challenges to TECW included: students' reluctance to collaborate and difficulties using new technology. Based on the review, we argue that teachers can influence the implementation of TECW from cognitive, metacognitive, behavioural, and motivational aspects. Teacher training, student autonomy, and the size of writing groups are potential areas for future research in TECW.

Keywords Collaborative writing · Second language writing · Language teaching · Teacher practice · Technology-enhanced language learning

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1 Introduction

Technology-enhanced collaborative writing (TECW) has been widely investigated and increasingly recognised as an effective approach to second and foreign language (L2) teaching and learning (Li, 2018; Su & Zou, 2020; Zou et al., 2018). TECW refers to writing activities in which two or more students work together to jointly produce a single text in their L2 (Storch, 2011, 2013, 2019). This activity can be even more flexible, enjoyable, and convenient with the aid of innovative technologies, such as wikis and Google Docs (Zhang & Zou, 2021a; Zou et al., 2020a), affording better interactivity and writing quality than the traditional, paper-based mode (Li, 2018; Storch, 2019). In the most recent decade, researchers have been investigating TECW and have reported convincing evidence for its usefulness in L2 learning (Storch, 2013; Zhang & Zou, 2021a; Zou et al., 2020b). They have found that students applied their newly learned knowledge, practised skills, pooled resources, exchanged opinions, and conducted self- and peer-reflection when practicing TECW (Chu et al., 2019; Li, 2018; Lin & Maarof, 2013). Therefore, students were likely to obtain better joint writing qualities (Abrams, 2019; Li & Zhu, 2017), enhanced individual writing proficiency (Bikowski & Vithanage, 2016; Hsu & Lo, 2018) and improved affective states (Ducate et al., 2011; Talib & Cheung, 2017).

Concurrent with its widening recognition, TECW has been increasingly used in educational settings (Storch, 2011, 2013) where the practice is important (Storch, 2011; Zhang & Zou, 2021a). The literature reveals that teacher practices of TECW, such as guiding students' selection and use of digital tools and strategies (Zhang et al., 2014) and providing pre-activity instruction and training (Li & Zhu, 2013, 2017), had a strong, positive influence on student performance, perceptions, and outcomes. The appropriate teacher practices of TECW may lead to optimised efficiency and effectiveness of this learning approach (Storch, 2011, 2019). However, practicing TECW appropriately can be challenging, considering the difficulties in organising and supporting collaborative learning tasks and technology-enhanced learning tasks compared to traditional teaching approaches (Pietarinen et al., 2021; Urhahne et al., 2010; Voyiatzaki & Avouris, 2014). Hence, it appears helpful to present a taxonomy of appropriate teacher practices, useful technology and possible challenges in implementing TECW to better prepare teachers and researchers for organising and supporting TECW activities.

Accordingly, this study reviews previous studies on TECW published from 2010 to 2021, focusing on teacher practices, technology, and challenges in implementing this activity. By undertaking this review, we aim to analyse effective TECW pedagogies, while identifying difficulties in implementing this learning approach and providing recommendations for future investigations in the field. Three questions guided this review:

1) How have teachers implemented TECW in previous studies?
2) How has technology been used to support the implementation of TECW?
3) What challenges impede the implementation of TECW?

2 Literature review

2.1 Collaborative writing

In collaborative writing for L2 development, students form groups of two or more and generate text based on in-group collaboration and communication (Storch, 2011, 2013). Multiple stages are involved in the process, including planning, drafting, writing, and revising (Bikowski & Vithanage, 2016; Zhang & Zou, 2021a; Zou & Xie, 2019), where all group members are required to participate without any division of labour (Storch, 2013, 2019).

During collaborative writing, students interact with each other following diversified patterns, of which Storch (2002) identified two determinants. One is equality, which refers to the even distribution of text production among students in one group; the other is mutuality, which refers to students' engagement with the contribution of their partners. Based on the two determinants, in-group interactive patterns in collaborative writing fall into four types: (a) "collective pattern," in which all group members share high levels of mutuality and equality; (b) "dominant/passive pattern," in which all group members share low levels of mutuality and equality; (c) "dominant/dominant pattern," in which group members have high levels of equality but low levels of mutuality; and (d) "expert/novice pattern," in which group members have high levels of mutuality but low levels of equality (Storch, 2002).

Researchers have applied various theoretical frameworks to analyse collaborative writing as a L2 educational approach. The collaborative theory contends that frequent peer-to-peer activities are essential for L2 development (e.g., Bikowski & Vithanage, 2016; Zhang et al., 2014). Collaborative writing affords rich peer-to-peer content negotiation, resource pooling, feedback exchange, and decision making (Li, 2018; Lin & Maarof, 2013; Storch, 2011); students apply their knowledge, skills and conduct self- and peer-reflection, thereby obtaining L2 development (Li, 2018; Lin & Maarof, 2013; Storch, 2011). Studies on collaborative writing often cite Vygotsky's sociocultural theory (1978) (e.g., Lin & Yang, 2011; Mohamadi, 2018), which argues that students perform better in tasks by learning from their more proficient peers (Vygotsky, 1978). Studies on L2 collaborative writing (Li & Zhu, 2017; Lin & Yang, 2011) have observed students examining, analysing, and learning from their peers and reported the overall positive effect of these behaviours on students' writing proficiency.

2.1.1 TECW

Various digital tools have increasingly been integrated into collaborative writing classroom practices after 2009 (Chen et al., 2021; Storch, 2019). Godwin-Jones (2003) analysed the directions and usefulness of technology-enhanced collaborative learning and listed a series of potential technologies, including Wimba, MSN Messenger, blogs, RSS, and wikis. Li (2018) conducted a systematic review of 21

relevant papers published from 2008 to 2017, while identifying computer technology, wikis, and Google Docs as the technologies applied most frequently in TECW. Storch (2019), who reviewed the most representative studies on collaborative writing from 1997 to 2017, found that most TECW activities were based on computer and web technology. Zhang and Zou (2021a) reviewed 34 empirical studies on TECW from the perspective of supportive technologies. The results showed that the six main technologies useful for TECW activities were wikis, Google Docs, chats, Facebook, forums, and offline word processors.

New technology has positively affected students' efficiency and perceptions of collaborative writing in L2 contexts (Li, 2018; Zhang & Zou, 2021a). It encourages students to interact with and learn from their peers, helps students conduct self-reflection and mistake-identification, boosts student motivation and confidence, makes writing and editing convenient, and contributes to a relaxing and interesting learning process (Zhang & Zou, 2021a). These advantages affirm the overall effectiveness of TECW, especially for improving students' joint writing qualities and individual writing proficiency (Li, 2018). However, TECW does not necessarily result in satisfying outcomes, especially when students have difficulty using unfamiliar technology or interacting in groups (Zhang & Zou, 2021a). Other factors, such as the type of writing task, the technology, the students' L2 proficiency levels, and in-group relationships, can also influence the effectiveness of TECW (Storch, 2011).

Due to the great potential of TECW, this learning approach has been increasingly investigated in recent years (Li, 2018; Zhang & Zou, 2021a). Li's review (2018) found that most studies have been in tertiary L2 contexts with students in small groups, with English as the target language and sociocultural theory as the theoretical framework. The writing tasks fell into traditional writing genres, research writing genres, and specific topic-related genres. The major research strands found within studies on TECW in L2 contexts concern in-group interaction, writing behaviours, joint writing outcomes, and learner perceptions of writing activities. In alignment with Li (2018), Storch (2019) identified learning behaviours in the writing process, in-group interactivity, and language learning outcomes as the primary research strands in the field of TECW.

2.2 Implementation of technology-enhanced collaborative learning activities

Researchers have made a considerable contribution to the field of collaborative learning. Hampel (2006) proposed a framework of language teaching and learning in a synchronous online environment in which classroom implementation of collaborative learning tasks consists of three phases: before, during, and after the task. Before the task, teachers assign their students warm-up activities and introduce the topic and the learning approach through instruction or discussion, helping students become familiar with the procedures and content of the task. To prepare for collaboration, teachers also form student groups and allocate students to roles in their group. During the task, teachers organise their instruction presentation and discussion. After the task, teachers give students feedback on their finished task, correct

their errors, and expand the task with additional group activities. Another theory related to the implementation of collaborative learning tasks is Smith's theory of the Accelerated Learning Cycle (Smith, 1996). To implement the learning activity, teachers (a) create a positive learning environment where students feel secure and motivated; (b) provide their students with the background knowledge of the activity; (c) set learning goals for the students; (d) provide students with new learning content; (e) manage and support the process of the learning activity; (f) demonstrate the outcomes of the activity to trigger student reflection; and (g) guide students to review and recall the activity for reinforcement and retention (Smith, 1996).

Teachers may take various strategies and practices to implement technology-enhanced collaborative learning efficiently (Lund, 2004; Voyiatzaki & Avouris, 2014). Lund (2004) conducted a comprehensive review of studies on computer-mediated collaborative learning from the perspective of human support in learning tasks and identified the essential impact of teacher practices on students' performance, efficiency, and affective states. Lund also specified five main types of teacher support in this learning activity: (a) pedagogical support for students' knowledge development; (b) managerial support for the organisation and proceeding of learning tasks; (c) social support for students' peer-to-peer interactivities; (d) interaction support for students' engagement in the learning tasks; and (e) technical support for students' use of technology. In another study, Urhahne et al. (2010) conducted an open-ended questionnaire among in-service teachers and identified five teacher practices essential for successful implementation of computer-supported collaborative learning projects: planning and modelling lessons; expediting peer-to-peer collaboration; boosting learner motivation; managing procedures of the learning activities; and evaluating the outcomes of the activities. Coll et al. (2014) analysed the performance of two groups of students in collaborative learning and reported three main areas teachers could support this learning activity: the learning content, students' engagement in the learning task, and students' in-group interactivity. Finally, four implications for teachers in implementing TECW for L2 development were provided by Zhang and Zou (2021a): the selection of technology, the assessment of students' technical literacy, the training on technology, and the instruction on TECW.

;2.3 Research gaps

Researchers have conducted many reviews related to TECW (e.g., Li, 2018; Storch, 2019; Zhang & Zou, 2021a) and implementing collaborative learning (e.g., Lund, 2004), but some limitations remain. First, most studies on TECW have focused on the design and outcomes of this activity (e.g., Storch, 2019; Zhang & Zou, 2021a), while few have focused on the implementation and teacher practices. However, implementing technology-enhanced collaborative learning tasks is complicated, requiring adequate knowledge and skilful practices by teachers (Hampel, 2006). To implement TECW, teachers play an essential role and must select and follow practices different from those used to implement traditional, individual L2 learning activities (see Urhahne et al., 2010; Voyiatzaki & Avouris, 2014). Their selection and practices have mediating effects on students' efficiency, perceptions, and

learning outcomes (Storch, 2019; Zhang & Zou, 2021a). Thus, presenting a taxonomy of appropriate teacher practices for implementing TECW may add value to the field by helping researchers and teachers become better prepared for this learning activity.

Second, most previous studies have focused on the technology of TECW from the perspective of learning (e.g., Godwin-Jones, 2003; Li, 2018), while few have focused on the implementational perspective. Although Zhang and Zou (2021a) have investigated the benefits of technology for teachers and researchers in TECW activities, discussions on how to practice different stages of TECW with the aid of various digital tools and online platforms remained insufficient. However, technology is essential for supporting teachers in technology-enhanced collaborative learning tasks (Kirkwood & Price, 2014; Shadiev & Yang, 2020). Equipped with digital tools and devices, teachers had different ways and capabilities to practice learning activities from those in the traditional classrooms (Pietarinen et al., 2021; Urhahne et al., 2010; Voyiatzaki & Avouris, 2014). Hence, it would have been helpful to analyse the ways technology supported the implementation of TECW and various TECW practices, preparing practitioners for the efficient use of technology in implementing this learning approach.

In addition, most previous reviews have focused on the advantages of TECW while focusing less on the challenges. However, challenges and difficulties probably exist in this complex learning activity that requires the application of various skills (Zhang & Zou, 2021a) and involves multiple stages (Abrams, 2016; Aydın & Yıldız, 2014). Only when both advantages and challenges of TECW have been well noted can practitioners be fully prepared for their implementation with maximised benefits and minimised problems. Hence, it appears beneficial to also present possible challenges in implementing TECW.

3 Method

This review adopted a three-step method, search, selection, and data analysis, following Fu and Hwang (2018), Zhang et al. (2021), and Zou et al. (2021). We searched data in the Web of Science Core Collection and Scopus, with "article" as the required document type and "English" as the required language, following many previous review studies in the field of technology-assisted language learning (e.g., Hung et al., 2018; Zhang & Zou, 2020, 2021b). The timespan of our search is "2010-present", as the number of studies on TECW has increased greatly since 2010. Storch (2019) also found that TECW started to draw increasing attention of the research community after 2009. Three groups of keywords were developed through the literature review (i.e., Li, 2018; Storch, 2019; Zhang & Zou, 2021a) including: (a) "collaborative writing" or "write collaboratively" or "collaborative written text" or "collaboratively write" or "collaboratively wrote" or "learn collaboratively through writing" or "collaborative learning;" (b) "language learning" or "learn language" or "language education" or "language acquisition" or "teach language" or "language teaching" or "English learning" or "English teaching" or

"English education;" and (c) "second language" or "foreign language" or "ESL" or "EFL" or "L2" or "SL" or "FL," with the AND operators between each. "ESL," "EFL," "SL," and "FL" are respectively the acronyms of "English as second language," "English as foreign language," "second language," and "foreign language."

3.1 Journal selection

To ensure that high-quality articles were selected, we included only Social Sciences Citation Index (SSCI) journals due to their excellent reputation in language education (Fu et al., 2022; Hung et al., 2018; Zhang & Zou, 2020). Non-SSCI journal articles, book chapters, and conference papers were included at an earlier stage of this search; however, they were excluded after we read a few of them and spotted a lack of rigor therein. Some studies failed to clearly and convincingly explain the procedures of implementing TECW. Others lacked important details concerning teacher practices in organising, supporting, and intervening in TECW. For example, one conference paper reported a study of wiki-enhanced collaborative writing but did not specify the exact procedures of its implementation. In another non-SSCI study, procedures of L2 students' engagement in a TECW activity were well-specified; however, there was no description of the teachers'/researchers' behaviours therein. Considering the focus of this review on teacher practices in TECW, the reviewed articles had to present detailed, specific, and clear descriptions of teacher practices in implementing TECW plus the reasons for these practices.

3.2 Article Selection

The search was conducted on Sep 3rd, 2021, generating a total of 521 articles, 469 from the Web of Science Core Collection and 52 from Scopus. We first removed 52 duplicates from the data pool and then screened the remaining 469 articles by titles and abstracts based on their relevance to the topic. Two inclusion criteria were applied: First, the article had to be related to TECW, which excluded 190 articles; second, the article had to be related to L2 learning, which excluded 97 articles. Subsequently, we screened the main texts of the remaining 182 articles based on three inclusion criteria and one exclusion criterion. First, the article had to focus on TECW for L2 learning. In some articles, TECW was not applied for L2 learning purposes. For example, in one study, the participants were required to perform TECW with students from foreign countries. The main purpose of TECW was cross-cultural collaboration, not language learning. This criterion excluded a further 91 articles. Second, the article had to report the implementation of TECW so that we could analyse teacher practices in this activity based on concrete, empirical data. This criterion excluded 24 articles. Third, the article had to include an explicit and precise description of teacher practices in implementing TECW. This criterion excluded 21 articles. Lastly, the research could not be on students with special needs because there are considerable differences between language education in general and special education (Scott & Windsor, 2000). This criterion excluded four articles.

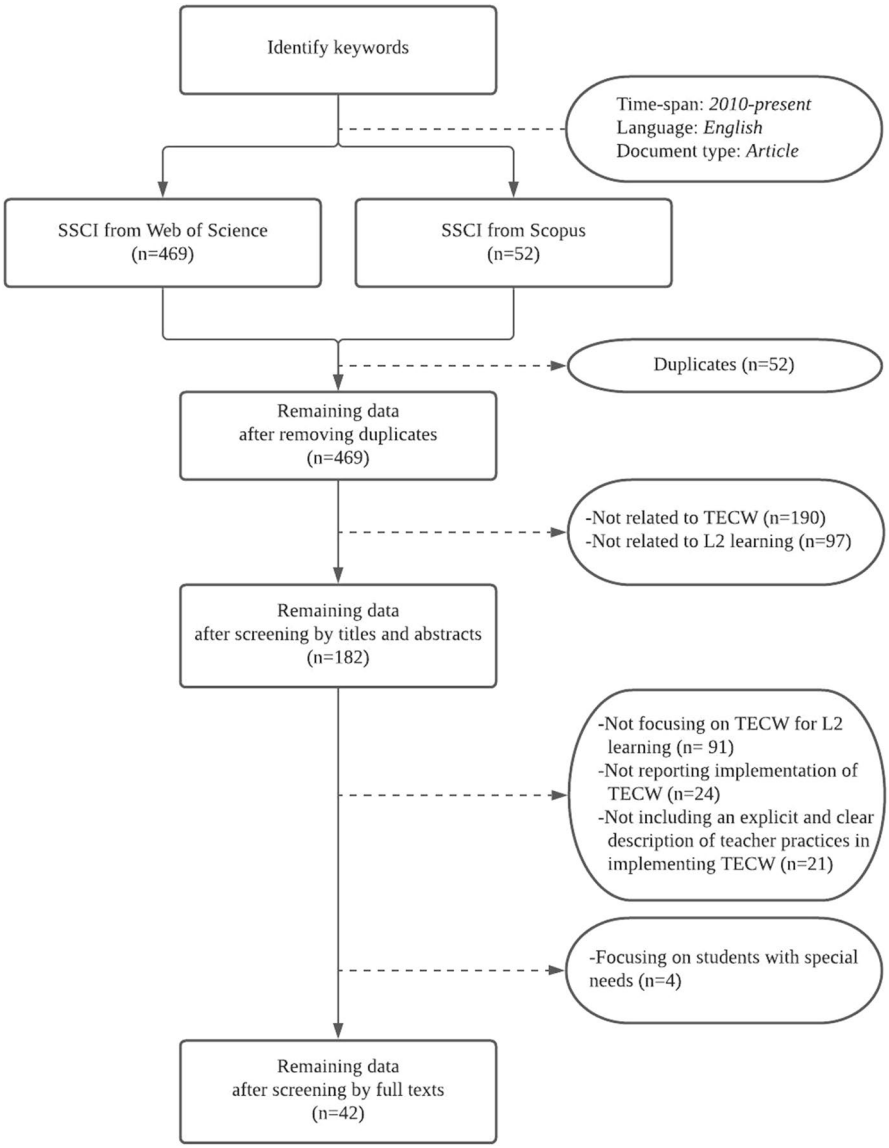

Fig. 1 Process of data collection and selection

The selection was finalised with 42 articles (see Reviewed articles). Figure 1 illustrates the process of data collection and selection.

3.3 Data analysis

To address the research questions, the 42 articles were analysed from three perspectives.

1) *Teacher practices in implementing TECW* This category concerns teachers'/researchers' behaviours and strategies for organising, supporting, intervening, and optimising TECW activities. Based on the literature review, the three phases used by teachers to implement technology-enhanced collaborative learning tasks (Hampel, 2006) were generalised as three codes. The first concerns pre-TECW practices (i.e., the teacher practices performed before TECW activities), including forming groups (Hampel, 2006), providing students with new learning content (Smith, 1996), and technology training (Zhang & Zou, 2021a). The second code concerns in-TECW practices (i.e., the teacher practices performed while learners participate in TECW activities), including managing the activities (Urhahne et al., 2010), maintaining students' engagement (Coll et al., 2014), and encouraging students' peer-to-peer interactivities (Lund, 2004). The third code is related to post-TECW practices (i.e., the teacher practices performed after the completion of TECW activities), including encouraging students' reflection on the learning activity (Smith, 1996) and giving feedback on the finished tasks (Hampel, 2006). Reasons for the teacher practices were also analysed.
2) *Technology in implementing TECW* This category concerns the types and use of digital tools and online systems that teachers/researchers have used to aid their implementation of TECW activities. Technology included collaborative study tools (e.g., Quip), schoolhouse or classroom-based technology (e.g., interactive white board), cloud-based word processors and shared documents (e.g., Google Doc), and network-based social computing (e.g., wikis), adapted from Loncar et al. (2021)'s categorisation of technologies and software for interactive activities for L2 writing development.
3) *Challenges in implementing TECW* This category concerns the difficulties and obstacles teachers/researchers have met in implementing TECW.

The authors first read and analysed five articles together to develop a coding scheme. Based on the jointly produced scheme, the authors coded the remaining articles independently, resulting in a satisfactory inter-rater reliability (Pearson's $r = 0.93$). The remaining differences were resolved via discussion and consultation with an expert in collaborative writing and technology-enhanced L2 learning.

4 Results

This section presents the review results concerning teacher practices, technology and challenges in implementing TECW. A summary of the results is presented in Appendix 1.

4.1 Teacher practices in implementing TECW

Our review identified nine teacher practices for organising and supporting TECW activities (Fig. 2). Six pre-TECW practices were reported in the reviewed articles, among which training students on collaboration was applied most frequently (21

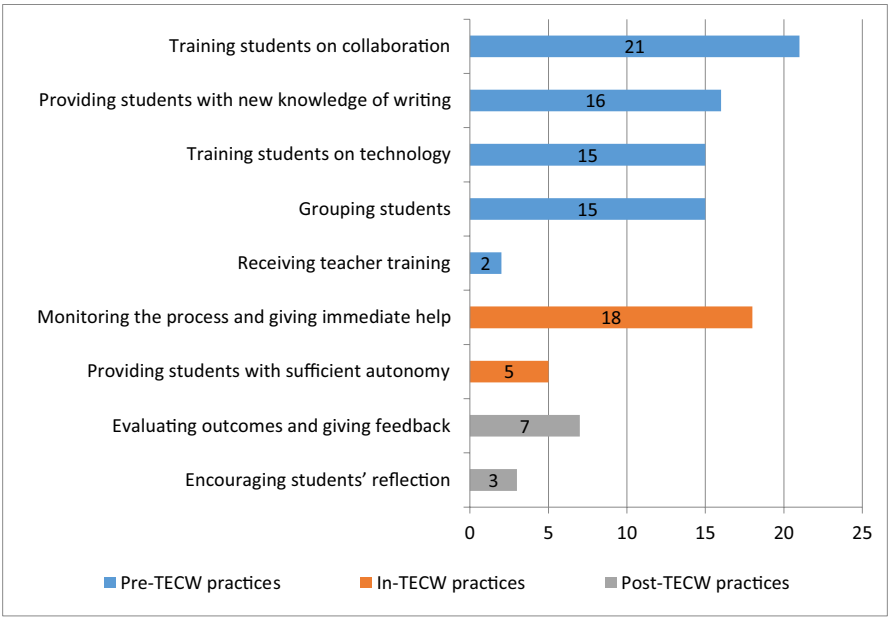

Fig. 2 Frequencies of teacher practices in TECW studies

studies), followed by providing students with new knowledge of writing (16 studies), training students on technology (15 studies), grouping studies (15 studies), and receiving teacher training (two studies). In-TECW practices included monitoring the process and giving immediate help (18 studies) and providing students with sufficient autonomy (five studies). We also found two post-TECW practices: evaluating outcomes and giving feedback (seven studies) and encouraging students' reflection (three studies). Many studies reported more than one teacher practice, so the sum is more than 42.

4.2 Pre-TECW practices

Our review revealed that before teaching TECW activities, teachers may prepare themselves by receiving training. As for the actual classroom procedures, our review showed that teachers often form writing groups among their students and provide training on technology, writing, and collaboration.

Receiving teacher training. To enhance their capabilities of managing and supporting TECW activities, our review found that some teachers prepared themselves in the knowledge and skills of TECW pedagogies (Bikowski & Vithanage, 2016; Zenouzagh, 2020). If the TECW project lasted for a relatively long time, such as one semester, teacher training should be held from time to time throughout the period, as applied by Bikowski and Vithanage (2016), so teachers can continuously develop comprehensive knowledge and skills for implementing TECW. The training contents

reported in the studies concern how to use digital tools and technologies (Bikowski & Vithanage, 2016), how to teach TECW (Bikowski & Vithanage, 2016), how to handle language classes and writing groups for TECW activities (Zenouzagh, 2020), and how to assess the outcomes of TECW and provide meaningful feedback (Zenouzagh, 2020). Zenouzagh (2020) and Bikowski and Vithanage (2016) also invited experts in TECW to host the training through briefing and lecturing.

Forming writing groups. TECW requires students to work in groups that need to be formed beforehand. The group sizes reported in the literature varied from two to 10. Groups of three were applied most frequently (Li & Zhu, 2016, 2017), followed by pairs (Hsu & Lo, 2018; Luquin & Mayo, 2021), groups of four or five (Kılıçkaya, 2020; Lin & Yang, 2011), and groups of three or four (Li & Kim, 2016; Wen et al., 2015). Our review identified three main methods of group formation. One concerned teachers' assigning writing groups actively (Abrams, 2016; Aydın & Yıldız, 2014). Teachers could assign group members randomly (Abrams, 2016) or based on students' characteristics and abilities, such as personality, communication and organisation skills (Bikowski & Vithanage, 2016), and language proficiency levels (Such, 2021). Bikowski and Vithanage (2016), for instance, formed the groups based around at least one student in each group who was proficient in the target language and strong in organisation skills. The second approach concerned students forming writing groups (Selcuk et al., 2019; Zhang, 2018). When allowed to form groups, students tended to select those they were originally familiar with as their partners (Selcuk et al., 2019) so they would feel comfortable working collaboratively (Hsu & Lo, 2018; Zhang, 2018). Hsu and Lo (2018) argued that the sense of comfort might raise the equality and mutuality of group interactivity in Storch's model (2002). It also encourages students to devote more time and effort to TECW activities (Zhang, 2018) and increases students' willingness to offer suggestions and challenge others' suggestions (Selcuk et al., 2019), thereby improving the efficiency and effectiveness of TECW activities (Zhang, 2018). Another method of student grouping consisted of two steps: first, students freely selected their partners and developed writing groups; and second, teachers adjusted the members in student-developed groups based on their beliefs about their students' L2 proficiency levels, first languages, and cultural backgrounds (Li & Zhu, 2016, 2017). This grouping method may have provided learners with a comfortable and familiar environment while maximising the efficiency and effectiveness of the learning activity.

Training students on technology. Many teachers provided their students with explicit training on technology for TECW (e.g., Rahimi & Fathi, 2021; Zenouzagh, 2020). Our review showed that the training content mainly concerned the knowledge and usage of operating environments and various features of technology (Hsu & Lo, 2018; Lin & Yang, 2011). For example, Li and Zhu (2013) and Hsu and Lo (2018) provided their students with training on the wiki tool, Wikispaces, before assigning them wiki-based collaborative writing tasks. During training, teachers first introduced the Wikispace sites and pages; they then demonstrated how to join the site and how to use the various features for TECW (e.g., "Discussion," "Comment," "Edit," and "History"). Kılıçkaya (2020) required their students to conduct TECW using a graphic writing tool, *Comic Life 3VR*. To familiarise students with the innovative tool, the researcher/teacher demonstrated various technical features useful for

TECW, such as template selection, text creation and edition, and shape insertion. In addition to explaining how to use the tool, teachers were advised to help their students understand the nature and purposes of various features and functions, so they would be able to apply them flexibly to address specific problems rather than using the tool for its own sake (Bikowski & Vithanage, 2016). Thus, they needed to provide explicit explanations (Bikowski & Vithanage, 2016) and organise discussions (Kılıçkaya, 2020) about the nature of new technology for TECW.

Training students on collaboration. The results showed that in previous studies, teachers provided students with training on communicative and collaborative skills for joint text production, helping them engage smoothly, comfortably, and efficiently in their groups (Bikowski & Vithanage, 2016; Zenouzagh, 2020). They taught their students how to provide relevant and valuable feedback and make corrections on others (Lin & Yang, 2011; Zhang et al., 2014), how to evaluate others' feedback and corrections and learn from them (Zenouzagh, 2020), how to be polite and respectful while avoiding over-politeness (Lin & Yang, 2011), and how to manage groups by setting group guidelines, utilising each group member's strengths, managing time, and considering group members' feelings (Bikowski & Vithanage, 2016). The training was usually in the form of lecturing the students (Ducate et al., 2011; Zhang, 2018). For example, Lin and Yang (2011) gave explicit lectures to their students on how to provide proper feedback and corrections, while presenting examples and counterexamples of various types of responses to peer feedback. In addition to skill development, Bikowski and Vithanage (2016) and Zhang (2018) enhanced their students' awareness of the value of collaboration in training. Only when students had well-understood the significance and purpose of collaboration, could they attach proper importance to it and shoulder their responsibilities in TECW (Bikowski & Vithanage, 2016; Zhang, 2018). Hence, Bikowski and Vithanage (2016) organised class discussions and led students to reflect on different interaction patterns, the value of collaboration in writing, and students' responsibilities when collaborating.

Providing students with new knowledge of writing. Many researchers and teachers claimed it is essential to help students develop L2 writing knowledge and skills prior to TECW, so students can efficiently engage in writing tasks (Elola & Oskoz, 2010; Van Steendam et al., 2014). The reported training contents included: instruction on genres and how to select topics (Chao & Lo, 2011; Mohamadi, 2018); how to expand knowledge and collect materials of writing topics (Woo et al., 2011, 2013); and how to create and improve the quality of jointly-produced texts (Van Steendam et al., 2014; Wang, 2014). For example, Wang (2014) taught their students about collaborative writing skills based on Tompkins's five writing stages (2004): "pre-writing, drafting, revising, editing, and publishing" (p. 386). Kılıçkaya (2020) systematically taught their students about the cognitive processes of writing (Fiorella & Mayer, 2015) that consisted of selecting, organising, and integrating. Woo et al., (2011, 2013) taught their students how to evaluate and extract valuable resources from the Internet and how to express main ideas through paraphrasing and summarising. The suggested training materials were instructional videos (Chao & Lo, 2011), guidance and checklists (Selcuk et al., 2019), templates (Wen et al., 2015), PowerPoint presentations (Chao & Lo, 2011; Mohamadi, 2018), textbooks (Elola & Oskoz, 2010), and wiki pages (Lai et al., 2016). For example, Zenouzagh (2020) and

Mohamadi (2018) lectured on writing skills and writing genres including lists of tips to avoid problems in TECW.

4.3 In-TECW practices

Our review identified the significance of teacher support and intervention during students' participation in TECW activities. Teachers promoted TECW by monitoring the process and giving immediate help while providing sufficient autonomy.

Monitoring the process and giving immediate help. Our review found that teachers monitored their students' activity progress during TECW (Abrams, 2019; Teng, 2021). When the activity occurred face-to-face, teachers should monitor students by frequently visiting each group (e.g., in Bikowski & Vithanage, 2016); when online, computer monitoring functions should be used to visit groups or follow their activity progress (e.g., in Zenouzagh, 2020). Teacher monitoring was found to be essential, whether face-to-face (Bikowski & Vithanage, 2016) or online (Zenouzagh, 2020), for making students feel the teachers' presence throughout the TECW activity, motivating them to attach more significance to the learning activity and devote more time and effort to it (Zenouzagh, 2020). Through close monitoring, teachers can spot mistakes and problems in time and provide answers, suggestions, encouragement, and immediate help (Chao & Lo, 2011; Woo et al., 2013). As for helping students' writing, we found teachers occasionally checked students' generation and editing of texts (Woo et al., 2013), provided suggestions (Aydın & Yıldız, 2014; Elola & Oskoz, 2010), and corrected their mistakes (Mohamadi, 2018). As for enhancing students' collaboration, teachers closely monitored group dynamics (Wen et al., 2015), guided students to support and scaffold each other (Manegre & Gutiérrez-Colón, 2020), and encouraged their participation in discussion (Wong et al., 2011) and resource sharing (Levrai & Bolster, 2019). Teachers also checked whether students were using new technology smoothly and efficiently (Bikowski & Vithanage, 2016; Li & Zhu, 2016). Additionally, it was recommended that teachers pay particular attention to the students who are relatively shy (Bikowski & Vithanage, 2016) and those with low proficiency (Wong et al., 2011) to help them engage in collaboration.

Providing sufficient autonomy. Despite the importance of teacher support, researchers advised teachers against excessive intervention (Bikowski & Vithanage, 2016). Only when students had sufficient control over TECW could they feel their ownership of the collaborative work and their responsibility in the activity (Bikowski & Vithanage, 2016). As reported in the literature, teachers should allow students to decide the specific content, style, and process of writing (Bradley et al., 2010; Li & Zhu, 2016). For example, interactive patterns and roles in groups should be decided by students themselves (Ducate et al., 2011). Students should also have the autonomy to choose which technology to use, such as the use of the Internet and the design of operating environments (Bradley et al., 2010).

4.4 Post-TECW practices

Our review results showed that teachers should give students feedback based on the outcomes of TECW and encourage their reflection on the finished activity.

Evaluating outcomes and giving feedback. Our review identified teachers' critical evaluation of students' writing outcomes and provision of feedback after TECW (Wang, 2014; Wen et al., 2015). In our review, this feedback usually consisted of correction (Elola & Oskoz, 2010), grading (Zenouzagh, 2020), comments (Wen et al., 2015), and suggestions (Wang, 2014), made from the aspects of content, grammar, structure, and organisation (Ducate et al., 2011; Hsu & Lo, 2018), provided to students through technologies, such as the "Comment" function of wikis (Elola & Oskoz, 2010). Teacher feedback can be a valuable reference for students, especially when the TECW project involves multiple rounds of drafting and revising (Hsu & Lo, 2018; Levrai & Bolster, 2019).

Encouraging students' reflection. This review identified the teacher practice of leading students to reflect on their previous engagement and performance and prepare for future ones (Abe, 2021; Levrai & Bolster, 2019). To encourage students' reflection, teachers should ask them to review the writing steps and knowledge points (Elola & Oskoz, 2010), analyse the value and needs of writing (Bikowski & Vithanage, 2016), evaluate their contribution to the group (Bikowski & Vithanage, 2016), and consider how to conduct TECW more effectively in the future (Bikowski & Vithanage, 2016). For example, after one TECW task, Elola and Oskoz (2010) showed their students model passages and different types of mistakes they had made during TECW, leading them to discuss these examples and mistakes and helping them review the involved knowledge points.

4.5 Technology in implementing TECW

Various types of technology have been used to support the TECW implementation. As shown in Fig. 3, network-based social computing was applied most frequently (28 studies), consisting of wikis (Lai et al., 2016), chats (Cho, 2017), forums (Levrai & Bolster, 2019, blogs (Zhang et al., 2014), and Facebook (Selcuk et al., 2019). Cloud-based word processors and shared documents were used in eight studies, consisting of Google Docs (Abrams, 2016) and EtherPad (Yeh, 2014). Schoolhouse or classroom-based technology was applied in seven studies, consisting of interactive white board (Teng, 2021), offline word processor (Luquin & Mayo, 2021), and EduVenture VR platform (Lin et al., 2021). Four studies applied collaborative study tools, consisting of Quip (Abe, 2021), Comic Life (Kılıçkaya, 2020), Stormboard (Levrai & Bolster, 2019), and Group Scribbles (Wen et al., 2015). The sum is bigger than 42 because some studies applied more than one type of technology in TECW implementation.

Our review identified the usefulness of technology in aiding various teacher practices for TECW implementation. Firstly, technology could support the pre-TECW training and knowledge transfer by expediting information delivery. Researchers

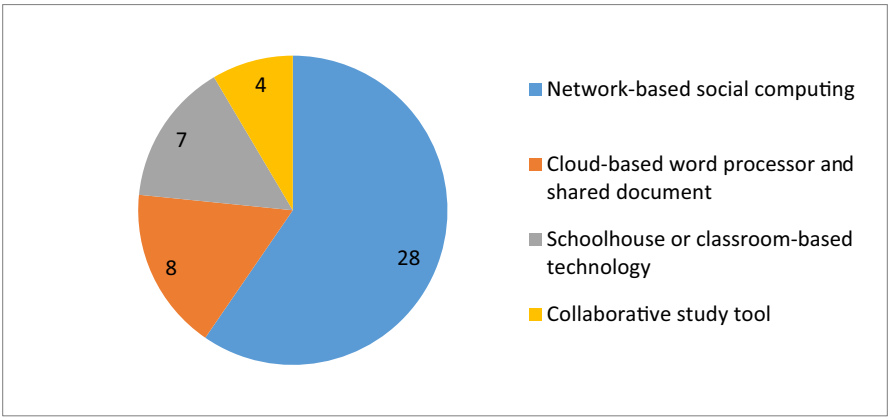

Fig. 3 Frequency of various technology used to implement TECW

reported the affordance of technology for systematically delivering instructional contents and supplementary materials for teaching and training students on writing, collaboration and technology. For example, Lai et al. (2016) developed two wiki pages for the pre-TECW training purpose: "How to Collaborate" introduced various interactive patterns and collaborative roles to their students; and "How to Write Well" presented explanations and tips of different stages of collaborative writing. The wiki-enhanced training and teaching enabled students to understand collaboration and collaborative writing clearly and comprehensively. Lin et al. (2021) provided students with writing knowledge via VR learning materials in the EduVenture VR platform, contributing to students' positive perception and vivid understanding of the target knowledge. In addition, teachers could use technology to present links to supplementary learning materials, expanding the training and teaching (Razak & Saeed, 2014; Selcuk et al., 2019). Evidence was found in Razak and Saeed (2014) who used Facebook posts to provide their students with links to extra learning resources related to collaborative writing.

Furthermore, technology could support teachers in student grouping by developing group workspaces and group chatrooms. Many types of technology enable the development of group workspaces for TECW, such as group pages and class pages of wikis (Bradley et al., 2010) and the "Grouping setting" module of Group Scribbles (Wen et al., 2015), where students could jointly draft, write, and revise with partners. Teachers can also use wiki modules to decide whether the writing group is private among group members or entirely open to all visitors (Bradley et al., 2010). Aydın and Yıldız (2014) reported a model use of wikis in student grouping who investigated university students' engagement in wiki-enhanced collaborative writing. They grouped their students by setting up class wikis for each class, creating wiki pages for each group under each class and organising all the pages in a navigation bar. Similarly, Abrams (2016) set up groups and assigned the members of each group by using the "Grouping" function of Google Docs. In addition, technology also enabled the development of group chatrooms, such as the "Chatroom" module

of Quip (Abe, 2021) and the "Discussion" module of wikis (Chao & Lo, 2011), in which students could engage in group discussion and negotiation for TECW without interference. For example, in Abe (2021), teachers used the "Chatroom" module of Quip to develop chatrooms for students' in-group communication. In the chatroom, students shared ideas, pooled knowledge and exchanged opinions about writing through synchronous and asynchronous messaging. The records of writing and editing progress would also be shown in the chatroom area.

Thirdly, technology could support teachers in monitoring the TECW process by recording students' writing and collaboration behaviours and visualising their thoughts. Wikis (Li & Zhu, 2016, 2017), Google Doc (Abrams, 2019), EtherPad (Yeh, 2014), and Quip (Abe, 2021) can automatically save students' writing processes, allowing teachers a clear and synchronous view of students' writing and revising behaviours in TECW. Some technology, such as wikis (Bradley et al., 2010) and Google Docs (Abrams, 2019), can even help teachers focus on specific students' behaviours by coding the contributions of different students in different colours. Examples were found in Woo et al. (2013) and Rahimi and Fathi (2021) who reported teachers monitoring students' writing and editing process in Wikispace. The collaboration process of TECW could also be instantly recorded, such as the "Discussion" module of wikis (Li, 2013), the "Discussion Board" module of Facebook (Razak & Saeed, 2014; Selcuk et al., 2019), and the "Chat" module of Skype (Cho, 2017), enabling teachers to monitor how students engaged in collaboration and interacted with their partners (Yeh, 2014). For example, in Wen et al. (2015), teachers used Group Scribble to check students' group dynamics in TECW. Moreover, Comic Life (Kılıçkaya, 2020) and interactive whiteboard (Teng, 2021) can provide teachers with a view of students' thinking process, enabling them to check students' understanding of learning materials and application of writing skills during TECW. Kılıçkaya (2020) provided a vivid example of teachers monitoring students' thinking process in TECW with the aid of Comic Life 3VR. Using Comic Life 3VR, students visualised their ideas and thoughts in writing by drawing graphics and making links between visual materials, while teachers monitored their students' thinking processes based on the visualisations.

In addition, technology could support teachers' provision of immediate help and feedback by enabling teacher commentary and posts. As described in the reviewed implementation of TECW, technology allowed teachers to make comments and suggestions on students' writing directly in lines, highlight the words and sentences in different colours for emphasis, and upload supplementary materials for instructional support (Elola & Oskoz, 2010; Woo et al., 2011, 2013). For example, in Levrai and Bolster (2019), teachers conducted in-line commentary on students' drafts of TECW in an online writing forum.

Finally, technology could assist teachers in encouraging students' reflection by presenting organised, analysed records of the TECW process. Wikis (Wang, 2015; Wong et al., 2011), Google Docs (Bikowski & Vithanage, 2016; Kessler et al., 2012), EtherPad (Yeh, 2014), Quip (Abe, 2021) and forum (Manegre & Gutiérrez-Colón, 2020) can automatically save, organise, and analyse the historical records, enabling teachers to lead their students to efficiently trace, review, and reflect on their TECW process. Further, wikis can calculate and visualise the frequency of

students' visits to wiki pages and contributions to the joint writing (Woo et al., 2011); and Google Docs can record the time student spend on different stages of writing (Abrams, 2019). These modules may enhance the quality and depth of student reflection. For example, Li (2013) used the "History" module of wikis to trace the process of TECW and categorised students' revising behaviours. Based on the results, teachers can lead students to accurately reflect on their revision process in TECW.

4.6 Challenges in implementing TECW

Most review articles reported successful implementation of TECW; however, some researchers noted challenges (Elola & Oskoz, 2010; Lin & Yang, 2011). One challenge concerned students' reluctance to collaborate. As reported in the literature, many students expressed their preference for writing by themselves rather than in groups (Ducate et al., 2011; Elola & Oskoz, 2010) because they were far more experienced in the former than the latter (Lin & Yang, 2011). Additionally, students usually preferred following their own style, schedule, and opinions, which sometimes differed from those of their group members (Elola & Oskoz, 2010). Students' limited L2 writing proficiency was also related to their reluctance to join a group. Some students were reluctant to accept peer feedback (Wang, 2014) because they felt uncertain about their partners' proficiency (Bikowski & Vithanage, 2016). Others felt too insecure and embarrassed to express their opinions and correct their peers due to their lack of confidence in their own proficiency (Lin & Yang, 2011; Wang, 2014). Students' reluctance to collaborate in writing might have largely reduced the quality of peer-to-peer interactivity in groups and negatively influenced students' perceptions and outcomes of TECW (Bikowski & Vithanage, 2016).

The other challenge for TECW implementation lay in students' difficulty in using unfamiliar technology. Although teachers and researchers in most studies selected "easy-to-learn" technology for their students (e.g., Chao & Lo, 2011; Wang, 2014, 2015), many students reported frustration (Ducate et al., 2011; Elola & Oskoz, 2010) and confusion with the complexity of features, functions, and interfaces (Elola & Oskoz, 2010; Lin & Yang, 2011). For example, many of Elola and Oskoz's students voiced difficulties using voice chat; Lin and Yang (2011) also reported that most of their students found wiki interfaces challenging to understand or use. Furthermore, technical problems led to students' reduced efficiency and waning enthusiasm for collaborative writing (Woo et al., 2011). Problems included: slow loading speeds, unstable Internet connections, and the inconvenience of using computers (Lin & Yang, 2011; Wang, 2014). For example, in Woo et al.'s (2011) study, students reported that it took over 30 min to access a document on average.

5 Discussion

Based on the review results, we have identified various aspects where teachers influence the implementation of TECW and suggested some implications for future researchers in the field.

5.1 Aspects where teachers influence the implementation of TECW

We identified four main areas where teachers can influence TECW. The first is cognitive (i.e., by developing knowledge and skills necessary to accomplish learning tasks). TECW involves dynamic interactions with multiple patterns (Storch, 2002), applications of L2 writing (Zhang & Zou, 2021a), and the use of various features and functions of innovative technology (Storch, 2019). Thus, students and teachers are more likely to implement TECW with high efficiency and satisfactory outcomes only when they are equipped with adequate knowledge and skills in these three areas through training (Lai et al., 2016; Zhang & Zou, 2021a). However, our review found students' continued lack of knowledge and skills of TECW even after training, especially concerning technical (e.g., Ducate et al., 2011; Elola & Oskoz, 2010) and collaborative abilities (e.g., Lin & Yang, 2011). This is likely because the brief training students received just before beginning their TECW tasks was insufficient to fully prepare them for this complex learning activity. Hence, we suggest teachers extend the preparation period for TECW, during which students should receive more systematic training on writing, collaboration, and technology, and fully familiarise themselves with this novel learning approach (Aydın & Yıldız, 2014; Chao & Lo, 2011). The application of technology may also be helpful to enhance the efficiency and outcomes of pre-TECW training (e.g., in Lai et al., 2016; Lin et al., 2021). Following Lai et al. (2016), teachers may develop wiki pages that systematically introduce knowledge and skills of collaboration, writing, and technology.

Secondly, teachers can influence the implementation of TECW from the motivational aspect (i.e., by managing students' affective states). Collaboration with peers and having a sense of responsibility are essential for TECW (Bikowski & Vithanage, 2016). However, students usually have only a shallow awareness of their responsibilities during collaboration due to their long-term experiences of traditional, individual, teacher-centred learning activities (Bai & Wang, 2020). This shallow awareness may lead to students' underestimation of the meaningfulness and importance of TECW and reduce their motivation and effort for this learning activity, resulting in unsuccessful implementation and unsatisfactory outcomes (Ducate et al., 2011; Elola & Oskoz, 2010). To enhance TECW from the motivational aspect, teachers can raise learners' awareness of the value of collaboration during TECW tasks (Bikowski & Vithanage, 2016; Zhang, 2018). Teachers, thus, should organise class discussions and encourage students to debate and reflect on the value of collaboration and their responsibilities in L2 learning (Bikowski & Vithanage, 2016). New technology can motivate in-group collaboration by creating a warm and relaxing learning environment (Chang & Lin, 2019; Chien et al., 2020). For example,

teachers could assign TECW tasks based on Facebook that is familiar to most students and supportive for discussion and commenting in multiple ways (Razak & Saeed, 2014; Zhang et al., 2014). The Facebook features can contribute to a relaxing learning atmosphere and better in-group relationships, raising students' awareness and willingness of collaboration (Shih, 2011).

Thirdly, teachers can influence the implementation of TECW from the behavioural aspect (i.e., by creating positive social and technical environments for learning). Our review showed that setting up writing groups impacts the social environment of learning. Depending on the size of the writing group, in-group interactional patterns and learning behaviours were likely to vary; for example, students in groups of five might have more opportunities than those in pairs for practising skills and learning from their peers (Teng, 2021). TECW may be performed smoothly and efficiently if teachers form writing groups based on their students' characteristics and abilities (Bikowski & Vithanage, 2016). Students may enjoy their relationships with other group members, have high motivation, and make an important contribution to the group if teachers allow them to select partners and form groups on their own (Hsu & Lo, 2018; Zhang, 2018). Furthermore, teachers can influence students' technical environment by selecting and adjusting the type of technology for TECW. Powerful, accessible, easy-to-learn, and easy-to-use digital tools had a positive impact on students' efficiency and perceptions of TECW (Chao & Lo, 2011; Wang, 2014, 2015), while technical problems, such as user-unfriendly tools and unstable Internet, may have the opposite effect (Lin & Yang, 2011; Wang, 2014). This finding echoes Yilmaz and Yilmaz's (2020) research results concerning the influence of technology on learner attitudes to collaborative learning tasks. Teachers can select Wikis and Google Docs for TECW, helping students engage in learning efficiently and conveniently (Zhang & Zou, 2021a). They can also allow students to personalise their use by selecting e-learning materials and designing operating interfaces, which can improve efficiency and confidence when using new technology in TECW (Bradley et al., 2010).

Fourthly, teachers can influence the implementation of TECW from the metacognitive aspect (i.e., by regulating and controlling the entire learning process). Due to the complexity of implementing TECW activities, teachers need to guide, regulate and control the entire learning process by monitoring (Abrams, 2019; Teng, 2021), time planning (Van Steendam et al., 2014), evaluating, and giving feedback (Wen et al., 2015). By monitoring the process of TECW, teachers can identify problems and needs in writing (Aydın & Yıldız, 2014), collaboration (Wen et al., 2015), and technology (Li & Zhu, 2016) and provide help immediately, helping the activity proceed smoothly (Mohamadi, 2018), echoing Yilmaz and Yilmaz's findings (2019). By planning the timing and maintaining order, teachers can increase students' efficiency (Bikowski & Vithanage, 2016) and engagement in the activity (Zenouzagh, 2020), thereby helping students complete their learning goals on time. By evaluating the outcomes and giving feedback, teachers can facilitate and reflect on the entire process of TECW, analyse the benefits and the problems of the implementation, and prepare for future tasks (Hampel, 2006; Smith, 1996). Teachers can apply new technology to enhance their efficiency of TECW implementation from the metacognitive aspects, for example, using Quip to monitor students' writing and collaboration

process (Abe, 2021), using Google Doc to manage students' timing in different stages of TECW (Abrams, 2019) and using wikis to review students' behaviours in TECW (Woo et al., 2011).

5.2 Implications for researchers

Some findings of our review align with previous research. For example, our review showed that teachers can prepare students for TECW by grouping them and providing them with TECW instructions. Teachers can also give students feedback on TECW when the task ends, echoing Hampel's (2006) framework of classroom implementation of collaborative learning tasks in an online environment. We also noted that instruction on the technical aspects of TECW before the activity (Rahimi & Fathi, 2021; Zenouzagh, 2020) and technical guidance during the activity (Bikowski & Vithanage, 2016; Li & Zhu, 2016) is helpful, consistent with Lund (2004). Additionally, we found evidence in many studies that teachers can improve TECW by enhancing in-group interactivity (Ducate et al., 2011; Zhang, 2018), in line with Urhahne et al. (2010) and Coll et al. (2014).

In addition to the similarities, this review produced some new findings. For example, we identified that teachers' reception of training before using TECW as a classroom method was helpful in enhancing its implementation, while previous research seldom discussed this. As shown in the review results, pre-TECW teacher training helped teachers develop knowledge and skills of TECW and enabled them to organise TECW and support students efficiently and skilfully (Bikowski & Vithanage, 2016; Zenouzagh, 2020). Because studies on teacher training for implementing TECW are few, future studies may be conducted in this direction.

Our review revealed the value of student autonomy in TECW, which has seldom been discussed in previous studies. As shown in our review results, students could not shoulder their responsibility for L2 learning and collaborative writing unless they were allowed sufficient control and autonomy over the activity (Bikowski & Vithanage, 2016; Zhang, 2018). Thus, teachers are recommended to allow students to decide the following: the content and method of writing (Bradley et al., 2010; Li & Zhu, 2016), the student roles and interactive patterns in collaboration (Ducate et al., 2011), and the way technology is used (Bradley et al., 2010), in order to provide students a feeling of autonomy and sense of duty (Bikowski & Vithanage, 2016). However, our results seem to conflict with Hampel (2006) who argued that teachers should control various situational factors in collaborative learning tasks and allocate students' roles in groups. To address this disagreement, we call for more contributions to investigate student autonomy in TECW.

Group size may also be a promising topic for future investigations on TECW. We found a wide variety of group sizes applied in TECW, ranging from two to 10. We also identified conflicting arguments concerning which group size might

optimise the effectiveness of TECW. For example, Li (2013), Zhang et al. (2014), and Bikowski and Vithanage (2016) contended that the ideal size of writing groups should be three or four, and a larger size may lead to low participation levels (Li, 2013) and heavy workload (Zhang et al., 2014); however, Teng (2021) claimed students in groups of five were more likely to learn from their peers and thereby have a better performance in TECW. Future studies may address conflicting arguments by investigating the effects of group size on students' implementation, perceptions, and outcomes of TECW.

6 Conclusions and limitations

This study conducted a review of 2010–2021 studies on TECW with foci on teacher practices, technology and challenges in implementing TECW. Nine main teacher practices performed in different phases of TECW were identified, falling into pre-TECW practices (i.e., receiving teacher training, grouping students, training students on collaboration, training students on technology, and providing students with new knowledge of writing), in-TECW practices (i.e., monitoring processes and giving immediate help and providing sufficient autonomy to students), and post-TECW practices (i.e., evaluating outcomes and giving feedback; encouraging students' reflection). The affordance of technology for TECW implementation included expediting information delivery, developing group workspaces and group chatrooms, recording students' writing and collaboration behaviours and visualising their thoughts, enabling teacher commentary and information post, and presenting organised, analysed records of the TECW process. Challenges to implementing TECW were related to students' reluctance to collaborate and difficulty using technologies.

Our review was not without limitations. First, our data included only SSCI journal articles from the Web of Science Core Collection and Scopus. To present a more comprehensive picture of TECW pedagogy, future research may expand the review list by including non-SSCI journal articles, book chapters, and conference papers indexed by AHCI, Google Scholar, etc. Second, our review did not statistically analyse the effectiveness of these practices. Future studies may conduct meta-analyses on teacher practices in TECW by calculating an effect size for each practice and the comparative effects of different teacher practices. Thirdly, this study focused on teacher practices in TECW tasks but did not investigate instruments for data collection and sample groups. Future studies may conduct a review from these perspectives to obtain a more comprehensive understanding of TECW activities.

Finally, teacher support before, during, and after the TECW activity was shown to be useful for improving the efficiency and effectiveness of this language learning approach. This study reveals language teachers' new responsibilities in an era in which student autonomy and technical support are increasingly valued in L2 education; accordingly, we call for more attention to the pedagogical aspects of technology-enhanced language learning.

Appendix 1

Table 1 Investigated group sizes, technology, and teacher practices in the reviewed studies

Authors	Group sizes	Technology	Teachers' practices
Abe (2021)	9 or 10	Quip	• Grouping students; • Providing students with new knowledge of writing; • Encouraging students' reflection
Abrams (2016)	3 or 4	Google Doc	• Grouping students
Abrams (2019)	3 or 4	Google Doc	• Monitoring process and giving immediate help
Aydın and Yıldız (2014)	4	Wikispace	• Grouping students; • Training students on technology; • Monitoring process and giving immediate help
Bradley et al. (2010)	2 or 3	Wikispace	• Allowing students with sufficient autonomy; • Monitoring process and giving immediate help
Bikowski and Vithanage (2016)	3 or 4	Google Doc	• Receiving teacher training; • Grouping students; • Training students on technology; • Training students on collaboration; • Allowing students with sufficient autonomy; • Monitoring process and giving immediate help; • Encouraging students' reflection
Chao and Lo (2011)	4 or 5	Wikispace	• Providing students with new knowledge of writing; • Monitoring process and giving immediate help
Cho (2017)	3	Google Doc, voice chat, text chat	Not specified
Ducate et al. (2011)	4 or 5	Wikispace	• Training students on technology; • Allowing students with sufficient autonomy; • Encouraging students' reflection

Authors	Group sizes	Technology	Teachers' practices
Elola and Oskoz (2010)	2	PBworks, voice chat, text chat	• Grouping students; • Providing students with new knowledge of writing; • Training students on technology; • Monitoring process and giving immediate help; • Evaluating outcomes and giving feedback
Hsu and Lo (2018)	2	Wikispace	• Grouping students; • Training students on technology; • Evaluating outcomes and giving feedback
Kessler et al. (2012)	3 or 4	Google Doc	Not specified
Kılıçkaya (2020)	4 or 5	Comic Life	• Training students on technology; • Training students on collaboration
Lai et al. (2016)	5	Wikispace	• Providing students with new knowledge of writing; • Training students on technology; • Training students on collaboration
Levrai and Bolster (2019)	2 or 3	Moodle-based forum, Stormboard, and Google Docs	• Monitoring process and giving immediate help; • Evaluating outcomes and giving feedback
Li (2013)	3	Wikispace	• Training students on technology
Li and Kim (2016)	3 or 4	Wikispace	• Grouping students
Li and Zhu (2013)	3	Wikispaces	Not specified
Li and Zhu (2016)	3	Wikispace	• Grouping students; • Allowing students with sufficient autonomy; • Monitoring process and giving immediate help
Li and Zhu (2017)	3	Wikispace	• Grouping students
Lin and Yang (2011)	4 or 5	Wetpaint	• Training students on technology; • Training students on collaboration
Lin et al. (2021)	2	EduVenture VR platform	• Providing students with new knowledge of writing

Authors	Group sizes	Technology	Teachers' practices
Luquin and Mayo (2021)	2	Offline word processor	• Training students on technology; • Providing students with new knowledge of writing; • Monitoring process and giving immediate help
Manegre and Gutiérrez-Colón (2020)	2	Knowledge building international project form	• Monitoring process and giving immediate help
Mohamadi (2018)	2	E-writing forum (e-writingforum.ir)	• Providing students with new knowledge of writing; • Monitoring process and giving immediate help
Rahimi and Fathi (2021)	3 or 4	Wikis	• Training students on technology; • Grouping students; • Monitoring process and giving immediate help
Razak and Saeed (2014)	5	Facebook	• Providing students with new knowledge of writing
Selcuk et al. (2019)	3	Facebook	• Grouping students; • Providing students with new knowledge of writing
Such (2021)	3 or 4	Wikispace	• Grouping students; • Providing students with new knowledge of writing; • Training students on technology
Teng (2021)	5	Interactive whiteboard, offline word processor	• Grouping students; • Providing students with new knowledge of writing; • Monitoring process and giving immediate help; • Evaluating outcomes and giving feedback
Van Steendam et al. (2014)	2	Offline word processor	• Providing students with new knowledge of writing; • Allowing students with sufficient autonomy
Wang (2014)	4 or 5	Wikispace	• Training students on technology; • Training students on collaboration; • Evaluating outcomes and giving feedback
Wang (2015)	4	Wikispace	• Training students on technology

Authors	Group sizes	Technology	Teachers' practices
Wen et al. (2015)	3 or 4	Group Scribbles, Interactive whiteboard	• Providing students with new knowledge of writing; • Training students on collaboration; • Monitoring process and giving immediate help; • Evaluating outcomes and giving feedback
Wong et al. (2011)	4 or 5	Wikispace	• Monitoring process and giving immediate help
Woo et al. (2011)	4, 5, or 6	PBworks	• Training students on collaboration
Woo et al. (2013)	4	Wikispaces	• Training students on collaboration; • Monitoring process and giving immediate help
Yamashita (2021)	2	Google Doc	• Grouping students; • Providing students with new knowledge of writing; • Monitoring process and giving immediate help
Yeh (2014)	3	EtherPad	• Providing students with new knowledge of writing
Zhang (2018)	2	Offline word processor	• Grouping students • Training students on collaboration
Zhang et al. (2014)	3 or 4	Blog	• Training students on collaboration
Zenouzagh (2020)	5	E-writing forum (e-writingforum.ir)	• Receiving teacher training; • Providing students with new knowledge of writing; • Training students on technology; • Monitoring process and giving immediate help; • Evaluating outcomes and giving feedback

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