Education and Information Technologies
https://doi.org/10.1007/s10639-024-12896-5

Exploring the impact of automated written corrective feedback on the academic writing skills of EFL learners: An activity theory perspective

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Received: 29 July 2023 / Accepted: 3 July 2024
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Abstract
Grounded in the activity theory, we adopted a sequential explanatory mixed-methods approach to explore the impact of automated written corrective feedback (AWCF) on English as a foreign language (EFL) learners' academic writing skills (i.e. task achievement, coherence and cohesion, lexicon, and grammatical range and accuracy). To this end, two intact classes were selected and randomly assigned to an electronic class (30 EFL learners), receiving AWCF electronically, and a non-electronic class (26 EFL learners), receiving written corrective feedback (WCF) non-electronically. Both groups of learners engaged in interactive writing activities guided by the principles of the activity theory, which capitalised on the roles of writing collaboration, social environment, and the mediation of electronic/nonelectronic artefacts to develop the writing skills. The required quantitative and qualitative data were collected via IELTS academic writing Task 1 and Task 2, a stimulated recall technique, and an individual semi-structured interview. The results of one-way ANCOVA indicated that the electronic learners outperformed their non-electronic counterparts in writing performance, task achievement, and grammatical range and accuracy, whilst no significant differences were found between the two groups' coherence and cohesion and lexicon. The stimulated recall technique, conducted with seven electronic EFL learners, confirmed the electronic learners' behavioural, cognitive, and affective engagement with the AWCF. The individual semi-structured interview, conducted with the same electronic learners, also indicated the electronic learners' positive and negative attitudes and perceptions towards the AWCF, further corroborating the findings. Pedagogical implications are discussed within the framework of the activity theory to clarify how instructional procedures and learning environments can be designed to more effectively contribute to EFL learners' interactive writing activities and, hence, their writing skills development.

Keywords AWCF · Academic writing skills · Activity theory · EFL learners

Extended author information available on the last page of the article

Published online: 30 July 2024

1 Introduction

Recent advances in English language learning and technology have focused on second and foreign language writing performance (Bai & Hu, 2017; Fathi & Rahimi, 2022; Laxton et al., 2021; Liu et al., 2022; Rahimi & Fathi, 2022; Tan et al., 2022; Zhang & Zou, 2022; Zou et al., 2023). Several writing-based technologies, including automated written corrective feedback (AWCF) platforms, have emerged in attempting to improve English language learners' writing performance (Barrot, 2023; Barrot & Agdeppa, 2021; Barrot & Gabinete, 2021; Li, 2021; Li et al., 2015; Osawa, 2023; Ranalli, 2021; Strobl et al., 2019). AWCF refers to an online-mediated programme that gives learners immediate feedback and comments to develop their written texts (Guo et al., 2022; Koltovskaia, 2020; Shermis et al., 2013). Learners can submit their written texts to an AWCF platform and receive feedback and comments on different subcomponents of their writing, such as task achievement, coherence and cohesion, lexicon, and grammatical range and accuracy, anywhere and anytime (Ebadi & Rahimi, 2018; Liao, 2016; Shang, 2022; Tan et al., 2022). AWCF could be differentiated from written corrective feedback (WCF), which is provided non-electronically, such as handwritten feedback in print or verbal feedback provided by a human instructor or learner during face-to-face sessions or after assignments are submitted (Cheng & Liu, 2022). AWCF follows immediate and consistent electronic feedback to address various writing skills and needs of language learners via an online platform or application. In addition, AWCF is guided by objective rules and norms to address specific writing skills and process a large number of written texts, whilst WCF can vary based on the individual styles, preferences, subjectivity, and personal biases of different instructors and learners who provide the feedback. (Gao & Ma, 2022; Lee, 2017).

AWCF-based platforms, which are more standardised and consistent in comparison with human raters, are believed to generate technology-supported quantitative and qualitative feedback on English language learners' writing, and provide more revision and editing opportunities (Dikli, 2006; Koltovskaia, 2020; Shadiev & Feng, 2023; Wang et al., 2013). Similar to other online platforms, AWCF platforms can deal with time limitations that most instructors in the English as a foreign language (EFL) context struggle against during their process-based writing courses (Barrot, 2023; Brudermann et al., 2021; Shadiev & Feng, 2023; Tan et al., 2022). Using AWCF platforms, instructors concentrate less on language-related issues of EFL learners' writing, such as grammar, punctuation, and spelling, as AWCF platforms provide adequate feedback and comments on such writing components. This helps instructors spend more time on learners' holistic writing performance, such as writing content and writing organisation (Warschauer & Grimes, 2008; Wilson & Czik, 2016). However, AWCF may primarily focus on surface-level writing issues, such as grammatical accuracy, lexicon, punctuation, spelling, and writing conventions, whilst human raters can offer in-depth qualitative feedback that goes beyond surface and minor writing issues and provide a richer understanding of learners' writing content and organisation (Wilson & Czik, 2016). AWCF may also provide incorrect feedback or suggestions since AWCF cannot understand the context, intent, writing style, and complex language structures of learners' writing (Guo et al., 2022; Ranalli, 2018).

Additionally, AWCF lacks the dynamic interaction and dialogue that can occur in human-to-human feedback exchanges, which can deprive learners of opportunities to seek clarification and engage in a deeper understanding of their feedback (Li, 2023; Woodworth & Barkaoui, 2020).

Several studies have focused on the impact of AWCF on EFL learners' writing skills using different AWCF platforms (Barrot, 2023; Guo et al., 2022; Ranalli, 2021). AWCF platforms have proven to contribute to EFL learners' writing skills (Ranalli, 2021; Stevenson & Phakiti, 2014), especially writing accuracy (Li & Li, 2018; Wang et al., 2013). However, gaps still exist in the literature exploring the empirical impact of AWCF on EFL learners' writing accuracy considering all dimensions related to the online feedback provided by the online platform. Moreover, although a substantial body of studies have explored the effects of AWCF on writing accuracy (e.g. Barrot, 2023; Saricaoglu & Bilki, 2021; Waer, 2023), previous studies on AWCF have not explored the effects of AWCF on different academic writing skills of EFL learners, including task achievement, coherence and cohesion, lexicon, and grammatical range and accuracy. On the other hand, the tripartite approach related to learning engagement, namely, behavioural (e.g. uptake and repair), cognitive (e.g. noticing and understanding), and affective (e.g. positive or negative perceptions) engagement (Ellis, 2010; Koltovskaia, 2020; Svalberg, 2009, 2017, 2021), which is assumed to substantially contribute to learners' learning processes, has not been sufficiently explored in AWCF studies.

Whilst exploring the impact of AWCF on writing skills provides valuable insights into EFL learners' writing development (Barrot, 2023; Ranalli, 2021), understanding EFL learners' behavioural, cognitive, and affective engagement ensures a more comprehensive view of the overall learning experience (Svalberg, 2017, 2021). Focusing on how actively and meaningfully learners engage in writing tasks can also clarify the processes through which AWCF impact EFL learners' writing skills (Koltovskaia, 2020). Exploring behavioural, cognitive, and affective engagement can further identify features that positively affect learners' engagement and utilise this information to design AWCF platforms in writing courses that correspond closely to learners' preferences and learning styles (Svalberg, 2021). In the current study, we explored the impact of AWCF on EFL learners' academic writing skills, comprising task achievement, coherence and cohesion, lexicon, and grammatical range and accuracy, with a special focus on writing accuracy, including grammar, punctuation, spelling, and some writing conventions. Being highlighted via AWCF platforms, writing conventions are writing norms, such as capitalisation, punctuation, spelling, and formatting, which ensure clarity and coherence in the written texts (Guo et al., 2022). AWCF provided by the online platform was also tracked to explore how the learners would address AWCF on the one hand, and how they are behaviourally, cognitively, and affectively engaged with AWCF on the other hand. Moreover, the learners' attitudes and perceptions towards AWCF were explored to shed more light on the learners' experience of AWCF.

The current study proposed a comprehensive understanding of how AWCF affected different writing areas. For instance, the findings suggested how effectively EFL learners could fulfil the requirements of writing tasks utilising the AWCF, which provided clear insights into the practical applicability of AWCF in achieving learn-

ers' writing goals. Additionally, the findings shed light on how well EFL learners could develop the logical organisation and flow of their writing using the AWCF, how effectively the AWCF could enrich their lexical resources, and how the AWCF could develop their grammatical proficiency, including the diversity and accuracy of sentence structures. This study also contributed to the understanding of how EFL learners interacted with and responded to technology-mediated feedback systems, and not only shed light on the effectiveness of AWCF in addressing writing skills but also gave deep insights into EFL learners' behavioural, cognitive, and affective engagement with such technological platforms. Furthermore, this study suggested valuable insights into the user experience of these feedback mechanisms, which informed the design and implementation of future technology-enhanced writing-based interventions. To address the objectives of the study, the following research questions were postulated:

RQ1 Are there any differences between AWCF (provided electronically) and WCF (provided non-electronically) in developing EFL learners' academic writing skills?

RQ2 How does AWCF impact EFL learners' behavioural, cognitive, and affective engagement?

RQ3 What attitudes and perceptions do EFL learners hold towards AWCF?

2 Literature review

2.1 Theoretical framework

The theoretical framework of the current study follows Engeström's (1987) activity theory. This theory capitalises on the interaction among human activities, social context, and artefacts to achieve the required objectives. This theory shows how individuals are engaged in different interactive activities and how different environmental factors may facilitate such interaction. According to Engeström (1987), this theory follows six subscales: subject, object, mediational artefact, rules, community, and division of labour. Subject, for example, refers to learners who are engaged in interactive language learning activities and share their own experiences and capabilities to contribute to the interactive language learning activities (Engeström, 1999; Liu et al., 2023). Object refers to the goals of the interactive language learning activities, such as achieving proficiency in English writing (Engeström, 1999; Liu et al., 2023). Mediational artefact is referred to as the platforms utilised by learners to engage in interactive language learning activities, such as online language learning platforms (Engeström, 1999; Liu et al., 2023). Community refers to the social setting in which interactive language learning activities occur, which can encompass language instructors, language learners, and the institution (Engeström, 1999; Liu et al., 2023). Rules are the norms and expectations that guide learners' interactive language learning activities in the community, such as classroom rules and language proficiency

standards (Engeström, 1999; Liu et al., 2023). Finally, Division of labour refers to different roles and responsibilities that different individuals take in the language learning community (Engeström, 1999; Liu et al., 2023). For instance, language instructors and learners may take different roles and responsibilities to develop language learners' writing skills (Engeström, 2001). The activity system model adapted from Engeström (1999) is demonstrated in Fig. 1.

The double-ended arrows in Fig. 1 indicate the interrelations between the subscales of the activity system (i.e. subject, object, mediational artefact, rule, community, and division of labour). In the present study, the EFL learners in both electronic and non-electronic classes were considered the subjects of the activity system. Both electronic and non-electronic learners were engaged in interactive writing activities to develop their academic writing skills in a community comprising EFL instructors and learners. The learners were responsible for sharing their ideas and recommendations for developing the required writing tasks during the interactive and individual writing activities. However, although an online platform was utilised in the electronic class as the mediational artefact to give the electronic learners AWCF to develop their academic writing skills, WCF was provided by the researcher/instructor in the non-electronic class to help the non-electronic learners develop their academic writing skills.

For the tensions between the subscales of the activity system in both the electronic and non-electronic classes in this study, we conducted a thorough analysis focusing

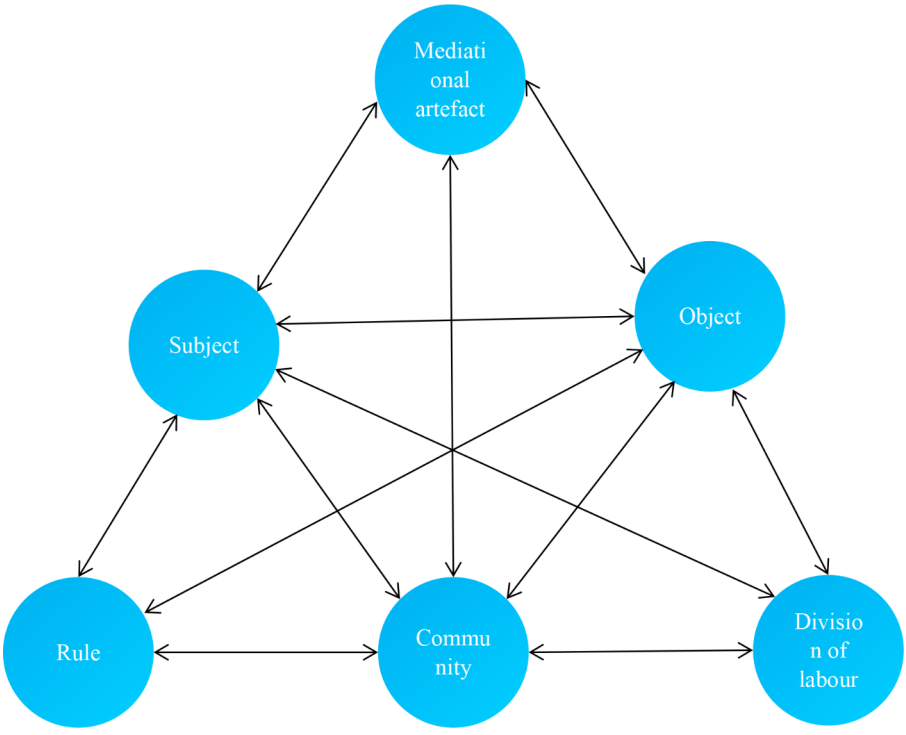

Fig. 1 The activity system model adapted from Engeström (1999)

on the interactions and interrelations among the key elements. This involved examining how each subscale, including subject (EFL learners), object (writing development goals), mediational artefact (AWCF or WCF platforms), rule (norms and expectations guiding writing activities), community (language learning environment), and division of labour (roles and responsibilities), interacted with one another. That is, we aimed to identify any discrepancies or conflicts that may arise between these subscales in each class. Tensions could manifest in various forms, such as inconsistencies in the EFL learners' engagement levels, discrepancies between the intended writing objectives and actual outcomes, or mismatches between the roles assigned to different participants and their actual contributions. Through this analysis, we sought to gain insights into the factors that may facilitate or hinder effective collaborative writing activities within each context. Recognising tensions between the subscales of the activity system was crucial as it helped uncover potential barriers to effective collaborative writing activities, and provided valuable insights for refining instructional practices and optimising writing environments. Further, by comparing the presence of tensions across the two classes, we could determine whether the integration of AWCF introduced unique challenges or benefits compared to WCF instructional procedures.

2.2 Automated written corrective feedback

WCF is referred to as the corrective feedback, related to language accuracy, provided to English language learners (Bitchener & Knoch, 2010; Ellis et al., 2006). Research in English language writing and technology has recently focused on the utility of online platforms in providing WCF, developing AWCF as a new writing construct. AWCF is conceptualised as WCF provided automatically by an online platform to help learners deal with the language-related issues of their writing drafts. AWCF, recognising learners' mistakes and errors in the areas of grammar, punctuation, spelling, and writing conventions, gives immediate feedback on learners' language-related issues, and provides them with sufficient time to revise their writing drafts. Learners are also provided with consistent and accurate metalinguistic explanations, which not only help them develop their writing accuracy but also help instructors tackle the time limitations they have for such metalinguistic explanations during collaborative and process-based writing activities. In addition, by providing direct feedback on writing mistakes and errors, AWCF has helped learners notice and correct their language-related issues more effectively and efficiently (Lee, 2017).

Several studies have been conducted to explore the impact of automated writing evaluation (AWE) on the writing performance of English language learners using different online platforms (Bai & Hu, 2017; Cheng, 2017; Jiang & Yu, 2022; Jiang et al., 2020; Ranalli, 2021; Waer, 2023; Wang et al., 2013; Zou et al., 2022). Waer (2023), for example, examined the impact of AWE on EFL students' writing apprehension and grammatical range and accuracy via an experimental design. A randomised, true-experimental research design was adopted to randomly assign 103 EFL students to an experimental and a control group. The online platform *Write & Improve* developed by Cambridge English was utilised in the experimental group to provide AWE on the students' writing tasks. *Write & Improve* uses the Common European Framework of Reference (CEFR) scale to assign each learner to an appropriate level (beginners A1

and A2, intermediate B1 and B2, and advanced C1 and C2) to help them accomplish a writing task (an essay, report, or a letter) properly. Collecting the required data via a grammar knowledge test, the findings indicated that students receiving AWE outperformed the non-AWE students in grammatical range and accuracy. Our study builds on Waer's study by exploring the impact of AWCF on grammatical range and accuracy, and other dimensions of writing performance (i.e. task achievement, coherence and cohesion, and lexicon) and learner engagement.

Wang et al. (2013) explored the effects of AWE on EFL learners' writing accuracy, autonomy, and interaction through an experimental research design. Fifty-seven first-year EFL students were randomly divided into experimental and control groups. Whilst the conventional, teacher-centred approach was followed in the control group to contribute to the students' writing performance, the online platform *CorrectEnglish* was applied in the experimental group to help the students improve their writing via AWE. *CorrectEnglish* examines students' grammatical structures, writing style, and appropriate word usage. Furthermore, this platform gives students immediate feedback on writing content, writing organisation, writing style, writing focus, and overall writing performance. A writing composition test and a self-report questionnaire were utilised to gather the required quantitative data and a semi-structured interview was conducted to collect the qualitative data. The results of the quantitative analysis indicated that the students using AWE outperformed those in the non-AWE class in terms of writing accuracy, autonomy, and interaction. The qualitative analysis also highlighted the students' positive viewpoints towards the utilisation of AWE for improving their writing accuracy and their autonomous learning. Our study complements Wang et al.'s study by concentrating on the specific impact of AWCF on EFL learners' writing skills, and shedding light on whether similar effects can be observed in a different context.

Saricaoglu and Bilki (2021) explored EFL learners' use of Criterion, an AWCF online platform, in their writing tasks and the extent to which their writing accuracy improved as a result of AWCF by following an action research design. Criterion gives learners immediate feedback both when learners are doing their writing tasks and when the completed writing drafts are submitted to the platform. Criterion also provides learners with a total writing mark and a summary writing performance report, including the number of words, sentences, and the committed errors that can help learners enhance their subsequent writing performance. A total number of 114 EFL learners in five classes volunteered to participate in the study. The learners were encouraged to submit their written text to Criterion, and address their writing issues based on the Criterion's feedback and comments. Tracking the learners' use of the tool and collecting their performance summary report, the findings showed that some of the learners denied using Criterion for accomplishing their writing drafts. However, the learners' engagement with AWCF diminished their errors in the last writing draft and enhanced their writing accuracy. Our study extends Saricaoglu and Bilki's study by further exploring the dynamics of learners' engagement with AWCF and its potential implications on writing skills. We aim to shed light on the connections between behavioural, cognitive, and affective engagement and writing outcomes.

Moreover, Barrot (2023) applied a quasi-experimental research design to explore the impact of AWCF using Grammarly on 65 English language learners' writing accu-

racy and writing errors. Both the experimental and the control groups were required to accomplish 10 200- to 300-word argumentative essay tasks. The experimental learners used Grammarly to receive AWCF for their writing tasks and improve their writing accordingly, whilst the control group utilised non-AWCF in their writing tasks. The required pre- and post-test data were collected by carrying out similar 200- to 300-word argumentative essay tasks. The results indicated that Grammarly-based AWCF developed the learners' writing accuracy since Grammarly could provide immediate metalinguistic explanations and enhance the learners' noticing and autonomous functioning.

Our study aims to add to the aforementioned studies by examining the broader effects of AWCF using Grammarly on writing skills, including task achievement, coherence and cohesion, lexicon, and grammatical range and accuracy. Regarded as the writing criteria of the International English Language Testing System (IELTS), task achievement, coherence and cohesion, lexicon, and grammatical range and accuracy provide specific aspects of writing proficiency that can be analysed to assess EFL learners' writing performance (Ebadi & Rahimi, 2018; Liao, 2016; Shang, 2022). Providing immediate and continuous feedback on lexicon and grammatical range and accuracy, AWCF can help EFL learners address the language-related issues of their writing tasks (Shang, 2022; Tan et al., 2022). On the other hand, AWCF can help EFL learners address their writing cohesion and writing coherence by helping them address writing issues, such as disjoined and ambiguous ideas, unsuitable transition devices, the absence of cohesive devices, and organisational and structural writing issues (Chen & Cui, 2022; Liu et al., 2016). Addressing the feedback on the aforementioned writing areas and having fulfilled the expectations of a specific genre or text type, AWCF also guides EFL learners on how to address the task achievement of their writing.

2.3 Grammarly

Grammarly is an English online writing platform identifying mistakes and errors in grammar, punctuation, spelling, and writing conventions (Grammarly, 2021). Grammarly, which is accessible both on its website and as an add-in for Word documents, provides synchronous explicit feedback on learners' writing drafts, which allows learners to correct their mistakes and errors immediately (Barrot, 2022; Koltovskaia, 2020; Zhu et al., 2020). Grammarly recognises and classifies learners' mistakes and errors by underlining them with various colours. A red line, for example, shows mistakes or errors related to grammar, punctuation, and spelling; a blue line indicates issues related to language clarity and conciseness; a purple line shows issues related to sentence formality and politeness; and a green line allows for a more engaging sentence. Grammarly also provides metalinguistic explanations related to mistakes and errors, which can further contribute to learners' writing accuracy. Learners can also select one of the English varieties of British, Australian, American, or Canadian English and receive pertinent feedback and metalinguistic explanations from Grammarly. Additionally, Grammarly allows for a more customised language, helping learners set their pertinent goals accordingly. Finally, following the proposed feedback and

the corrections, Grammarly provides learners with a report showing the word count, readability, and a norm-referenced mark of their writing draft (Barrot, 2022, 2021).

Previous studies have also focused on the impact of AWCF using Grammarly on English language learners' writing performance (Barrot, 2023; Koltovskaia, 2020; Tan et al., 2022). Ranalli (2021), for instance, explored English language students' engagement with Grammarly-based AWE through screencasts, stimulated recalls, and interviews. Ranalli indicated that based on the feedback provided by Grammarly, the students would have a proofreading of the AWE before changing their writing drafts. That is, the students would accept some feedback provided by Grammarly and revise their writing drafts accordingly, whilst they ignored tackling some feedback. In addition, the students would proofread instead of having a learning orientation towards the provided feedback since they thought the majority of the feedback was about specific and minor mistakes and required little work on the students' part. In a similar vein, Tan et al. (2022) explored the impact of three electronic feedback modes, namely AWCF, asynchronous computer-mediated communication (ACMC), and the combination of AWCF and ACMC on EFL learners' writing complexity, accuracy, and fluency (CAF). Tan et al. found that the learners receiving the combination of AWCF and ACMC were more successful than the other groups in writing CAF. Moreover, the learners held positive attitudes and perceptions towards AWCF plus ACMC mode.

Our study extends the aforementioned studies by specifically concentrating on AWCF using Grammarly for writing skills and exploring a detailed examination of EFL learners' behavioural, cognitive, and affective engagement. According to Svalberg (2009), engagement with language learning activities comprises behavioural, cognitive, and affective dimensions, all of which influence how learners successfully do a language learning task. Behavioural engagement is referred to as observable actions, collaboration, support, reactiveness, initiation of interaction, and task accomplishment (Svalberg, 2009, 2017, 2021). AWCF can develop behavioural engagement by engaging EFL learners in further collaborative writing activities prompted by feedback, and providing feedback and comments on writing tasks. That is, the collaborative features of AWCF encourage learners to interact not only with the platform but also with other peers and the instructor to create a more socially embedded and behaviourally engaging language learning experience. It is argued that "all dimensions of engagement are manifested behaviorally" (Svalberg, 2021, p. 42). That is, when learners are engaged in an activity, their cognitive and affective involvement, commitment, and interaction with that activity are observable through their behaviour.

Cognitive engagement, on the other hand, refers to active mental processes, focused attention, alertness, and cognitive or mental effort during learning (Svalberg, 2009, 2017, 2021). AWCF can enhance cognitive engagement by reducing the cognitive load (i.e. the mental effort required for processing information) and automatising the feedback process for EFL learners. Instead of manually analysing and addressing each aspect of their writing issues, learners can rely on the automated platform to provide immediate feedback, which can diminish the cognitive load associated with waiting for feedback or revisiting writing issues later. This allows learners to concentrate more on the creative and conceptual aspects of their writing. Learners

are believed not only to passively receive AWCF but also to actively process it by considering aspects like grammar and vocabulary choices and applying them in their writing, which can impact their cognitive engagement in the learning task (Svalberg, 2021). Finally, affective engagement encompasses the emotions, attitudes, purposefulness, and autonomy of learning (Svalberg, 2009, 2017, 2021). As AWCF contributes to self-revising, self-editing, and self-directing writing tasks, AWCF may positively influence EFL learners' affective engagement, which may result in writing motivation and enjoyment. On the other hand, timely and constructive feedback from AWCF platforms can evoke positive emotions, such as satisfaction and accomplishment in learners, which contribute to a more positive affective engagement with the writing tasks. Moreover, since learners receive guidance on developing their writing skills, they may feel more motivated, more confident, and less anxious about their writing tasks, which may positively impact their affective engagement (Svalberg, 2021).

Regarding the tripartite approach related to learning engagement, Koltovskaia (2020), for instance, conducted a case study to explore two English language students' behavioural, cognitive, and affective engagement with AWCF using Grammarly. Collecting the required data through screencasts, stimulated recall, and a semi-structured interview, Koltovskaia indicated the students' various levels of engagement with AWCF. For instance, it was revealed that one of the students, who had a greater cognitive engagement, relied less on AWCF, which resulted in moderate changes to their writing draft. Another student, who showed less cognitive engagement, relied more on AWCF; however, AWCF did not have a great impact on their writing draft. Our study follows up on this case study by expanding the investigation to a broader group of EFL learners and assessing the collective impact on writing skills. That is, we further explored the behavioural, cognitive, and affective engagement of EFL learners with Grammarly, aiming to provide a comprehensive view of the impact of AWCF on EFL learners' writing skills (i.e. task achievement, coherence and cohesion, lexicon, and grammatical range and accuracy).

2.4 Purpose of the study

The literature indicated the positive role of AWCF in developing EFL learners' writing skill, especially their writing accuracy (Barrot, 2023; Saricaoglu & Bilki, 2021; Waer, 2023). The literature also revealed the positive perceptions and learning engagement of EFL learners towards the effects of AWCF on writing skills (Koltovskaia, 2020; Ranalli, 2021; Svalberg, 2021). However, there is a lack of research exploring the impact of AWCF on EFL learners' writing skills, including task achievement, coherence and cohesion, lexicon, and grammatical range and accuracy, and their learning engagement, including behavioural, cognitive, and affective engagement. Therefore, in this study we explored the impact of AWCF utilising Grammarly on the aforementioned writing skills and learning engagement of EFL learners. In addition, we explored the EFL learners' attitudes and perceptions towards the impact of the AWCF on their writing skills and learning engagement. The findings proposed deep insights into how AWCF using Grammarly fostered EFL learners' writing skills and learning engagement. The findings of this study informed instructional practices, curricu-

lum development, and the design of language learning technologies for developing EFL learners' writing skills. Additionally, exploring how AWCF affected behavioural engagement via collaborative writing activities, cognitive engagement by reducing cognitive load and promoting active processing of feedback, and affective engagement by fostering positive emotions and motivation, this study provided comprehensive insights into the processes through which AWCF developed writing engagement. Realising these writing processes contributed to the development of more effective interactive writing interventions and supportive and engaging learning environment for EFL learners. Insights obtained from this study further informed the development of more user-friendly and effective AWCF platforms to meet the diverse needs and preferences of EFL learners.

3 Method

3.1 Design of the study

A sequential explanatory mixed-methods design (Creswell et al., 2003; Ivankova et al., 2006) was used in this study. Sequential explanatory mixed-methods research design integrates both quantitative and qualitative data collection and analysis in a sequential manner to more comprehensively address the research enquiries of a study. That is, quantitative data collection and analysis are initially carried out, followed by subsequent qualitative data collection and analysis to provide further explanations about the findings of the study. A quasi-experimental research design was followed to collect the required quantitative data from two classes: one utilising an electronic platform applying AWCF and the other using a non-electronic class applying WCF, both before and after the treatment (Friedman et al., 2010). The pre- and post-test writing assessments were administered prior to and after the interventions to quantitatively examine the electronic and non-electronic EFL learners' writing development. Subsequently, individual semi-structured interviews were conducted with EFL learners who performed more successfully in writing skills to qualitatively explain the findings. Understanding how the high-performing learners experienced either AWCF or WCF can reveal insights into their learning experiences and challenges. Such qualitative explorations allowed us to go beyond the statistical analyses and understand other learner-related attitudinal factors that led to more writing development.

The utilisation of both a sequential explanatory mixed-methods design and a quasi-experimental research design in this study was based on the need to comprehensively address the research enquiries from multiple perspectives, and provide substantial evidence regarding the impact of AWCF on EFL learners' writing skills. The sequential explanatory mixed-methods design was utilised to capitalise on the strengths of both quantitative and qualitative methodologies in understanding the complex phenomenon under exploration. That is, by integrating quantitative data collection and analysis with subsequent qualitative data collection and analysis, this design allowed for a holistic exploration of the research enquiries. On the other hand, the quasi-experimental research design was utilised to facilitate the rigorous compar-

ison of writing outcomes between the two instructional conditions: electronic class with AWCF and non-electronic class with conventional WCF.

3.2 Context and participants

The current study took place in a developing country where the utilisation of technological platforms in educational settings, especially for developing learners' writing skills, was constrained. In this EFL context, conventional methods of teaching and learning were predominantly adopted prior to this study. This cultural background significantly formed the educational atmosphere, as technological interventions, such as AWCF, were not commonplace. Applying a convenience sampling approach (Dörnyei, 2007), a total of 56 EFL learners (in the 20–28 age range) whose native language was either Kurdish or Persian made up the current study's participants. The native language distribution was as follows: 38 EFL learners were native speakers of Kurdish (accounting for 67.8% of the participants), whilst 18 learners were native speakers of Persian (representing 32.2% of the participants). Among the Kurdish participants, 22 were female (57.1%) and 16 were male (42.9%), whilst among the Persian participants, 10 were female (55.6%) and 8 were male (44.4%). The participants were in two intact classes: an electronic class (consisting of 30 EFL learners representing 53.6% of the participants) and a non-electronic class (comprised of 26 EFL learners representing 46.4% of the participants). The learners in both classes were preparing themselves for the IELTS examination, so they were expected to master the four English language skills, including academic writing. The two classes were taught by the same researcher/instructor who was experienced in implementing online platforms in the EFL context.

The two classes were randomly assigned to an electronic class (30 EFL learners) and a non-electronic class (26 EFL learners). This random assignment was carried out utilising a computer-generated randomisation procedure which ensured an equal probability of each class being assigned to either condition. Moreover, to ensure the integrity and fairness of the randomisation process, the researcher/instructor running and supervising the study was blinded to the allocation sequence until the completion of the random assignment. The randomisation process aimed to minimise any potential biases or influences that could affect the assignment of the two groups to either electronic or non-electronic class, thereby enhancing the reliability and validity of the findings. Although following the CEFR and the standards of the institution the EFL learners in both groups were at B1 level (i.e. intermediate level), Oxford Placement Test (OPT) (Allan, 2004) was also utilised to ensure the homogeneity of the two groups with regard to their level of general English language ability before the treatment. The results of an independent samples t-test, used to compare the electronic and non-electronic groups' general English language ability, revealed no initial variations in the English language competence levels between the electronic and non-electronic learners.

3.3 The intervention processes

3.3.1 Electronic class

The learners using a writing topic made plans for what they would write using a variety of strategies, including freewriting and brainstorming (pre-writing stage). The learners then completed their first writing draft and submitted it to the researcher/instructor to receive feedback on major writing issues. The learners addressing the major writing comments revised their writing draft and posted it to the online platform to receive AWCF. The final step was for the learners to revise the final writing draft in light of the AWCF they had received. At the end of each writing task, the researcher/instructor and another experienced researcher intended to evaluate the final writing draft based on the IELTS band descriptors. For the purpose of data analysis, only the AWCF provided by the online platform was taken into account. The steps used to complete a writing task in the electronic class have been demonstrated in Fig. 2.

The process of collaborative revision was an integral part of the writing task completion aimed at fostering a collaborative learning environment and developing the quality of written texts among the EFL learners. The collaborative revi-

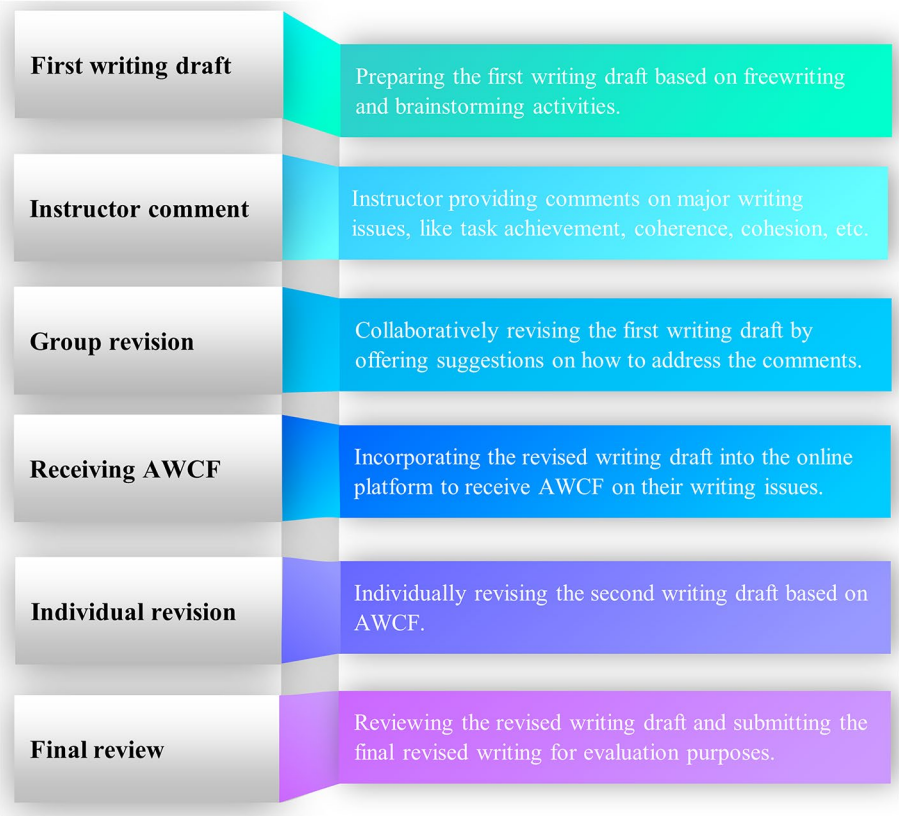

Fig. 2 The processes of accomplishing a writing task in the electronic class

sion involved a structured series of steps that facilitated both peer and researcher/instructor feedback, and encouraged active engagement and iterative refinement of the writing drafts. Initially, the learners engaged in pre-writing activities, such as freewriting and brainstorming, to generate ideas for their writing topics. Following this, they independently completed their first writing draft, which was then submitted to the researcher/instructor for written feedback. The provided feedback primarily addressed major writing issues, encompassing task achievement, coherence, cohesion, and overall organisation of the writing. Subsequently, a collaborative revision process was followed, where the learners actively participated in discussions, offered suggestions, and collectively made decisions on how to implement the feedback. As part of the writing process, this collaborative exchange aimed to encourage peer interaction and foster a deeper understanding of writing conventions and strategies among the learners.

Once the initial collaborative revision phase was completed, the learners individually revised their second writing drafts based on the AWCF received via the online platform. This individual revision phase allowed the learners to incorporate the specific language-related feedback on grammar, punctuation, spelling, and other pertinent writing issues provided by the platform. Finally, each learner reviewed and revised their writing draft individually to ensure that development was made based on the received feedback. This approach aimed to combine the benefits of collaborative input and individual revision in enhancing the overall quality of the written texts. The revised writing drafts were then submitted for evaluation purposes, where the researcher/instructor and another experienced professional utilised the IELTS band descriptors to evaluate the final writing submissions. The final writing draft submitted for evaluation was considered an individual work that reflected the learners' own synthesis of the feedback they received from the researcher/instructor and their peers. After incorporating the feedback received during the collaborative phase and receiving the AWCF, each learner revised their work individually to ensure personal understanding and application of the provided feedback.

3.3.2 Non-electronic class

The same academic writing instruction was given to the learners in the non-electronic class except for the online platform's AWCF. The non-electronic learners experiencing the pre-writing stage accomplished the first writing draft and submitted it to the researcher/instructor to receive feedback on major writing issues. After addressing the major writing issues, the learners prepared the second writing draft and submitted it to the researcher/instructor one more time to receive WCF. The learners revised the writing draft based on the researcher/instructor's WCF and prepared the final writing draft collectively. Similar to the electronic class, the researcher/instructor and another debriefed researcher marked the final writing draft following the IELTS band descriptors at the end of each writing task. As for the data analysis purposes, only WCF provided by the researcher/instructor on the second writing draft was taken into consideration since only the form of giving the corrective feedback was different in both groups (i.e. either the corrective feedback was provided electronically or non-

electronically). The processes applied to do a writing task in the non-electronic class have been presented in Fig. 3.

Both classes took one term (10 weeks), they were held twice per week (20 sessions), each session lasted for 90 min, and each group completed four collaborative writing tasks during the term.

3.4 Data collection instruments

3.4.1 IELTS academic writing tasks

IELTS academic writing Task 1 and Task 2 were used to evaluate the participants' writing skills in both electronic and non-electronic groups. The two varieties of IELTS writing tasks were chosen from *IELTS advantage writing skills* (i.e. the two groups' coursebook) developed by Brown and Richards (2017). The academic writing Task 1 and Task 2 of the respondents were marked using IELTS writing band descriptors, which evaluated the learners' academic writing abilities in four areas of task achievement (i.e. outlining key points, providing an overview and factual data, and the number of words), coherence and cohesion (i.e. the arrangement of information,

Fig. 3 The processes of accomplishing a writing task in the non-electronic class

paragraph formatting, and linking devices), lexicon (i.e. utilising right terminologies, applying correct collocations, and addressing erroneous sentences), and grammatical range and accuracy (i.e. employing a variety of grammar tenses, punctuation, and the number of errors committed).

In the present study, each section of the test (i.e. task achievement, coherence and cohesion, lexicon, and grammatical range and accuracy) was assigned a mark from 1 to 9. A Band 9 candidate fully addresses task requirements and presents a well-developed position with fully extended and well-supported ideas. In coherence and cohesion, a Band 9 candidate skilfully applies cohesive devices and demonstrates a clear and effective overall structure. Regarding lexical resources, a Band 9 candidate utilises a wide range of vocabulary with precision, and incorporates idiomatic language naturally and accurately. In grammatical range and accuracy, a Band 9 candidate employs a broad range of structures with full flexibility, showing rare and minor errors that do not hinder communication. marks progressively decrease for lower bands, indicating varying degrees of proficiency in these key writing areas.

The academic writing skills of each learner were evaluated and marked by the researcher/instructor. Thirty per cent of the learners' marks came from writing Task 1 and 60 per cent from writing Task 2. Each learner's final IELTS academic writing skills mark was determined by adding together their writing Task 1 and Task 2 marks, which varied from 1 to 9 at increments of 0.5. Inter-rater dependability was conducted to lessen the subjectivity in the marking process. To this aim, another skilled and fully briefed IELTS instructor judged the learners' academic writing skills marks to confirm the reliability of the results. The findings showed that there was reasonable agreement between the two raters' marks ($r = 0.84$).

3.4.2 Stimulated recall

As the stimulated recall technique (Gass & Mackey, 2000), a think-aloud alternative, is believed to be the best method for gathering data about learners' behavioural, cognitive, and affective processes, a stimulated recall technique was carried out with seven participating EFL learners in the electronic group. Care was taken to pick a variety of EFL learners who marked poorly, moderately, and highly on the writing post-tests. Additionally, each learner willingly agreed to take part in the stimulated recall technique. The stimulated recall technique was conducted following ethical guidelines for research involving human participants. Prior to the stimulated recall sessions, all the participating learners provided informed consent, which included a detailed explanation of the study procedures, including the use of screen recording. The learners' pseudonyms L1, L2, …, and L7 were employed to protect their identities.

The learners' activities (addressing AWCF) in one session were initially screen-recorded using Camtasia (http://www.techsmith.com/camtasia.html), which is a powerful software programme for screen recording developed by TechSmith. For ethical purposes, the screen recordings were stored securely and deleted after the completion of the study. Immediately after the screencast session, individual interviews were conducted with the seven participating learners. Efforts were made to conduct the follow-up interviews promptly after the screencast sessions to ensure the timeline

and accuracy of the learners' recall (Gass & Mackey, 2000). On average, the duration between the screencast session and the follow-up interviews was approximately 24 to 48 h. During the interview session, the learners were shown the screencasts of their performance on the second writing draft at the same time so that they could better describe the ideas they were having whilst addressing the provided feedback online.

The learners were prompted to remember their behavioural, cognitive, and affective engagement during their performance by asking them questions, such as "You accepted this corrective feedback and applied it, why?" and "You rejected this corrective feedback and did not apply it, why?" using their native language. These questions helped the researcher/instructor gain insights into the learners' underlying thoughts and motivation. To enable the learners to recall their behavioural, cognitive, and affective engagement during their writing performance, the screen recordings of their interactions with the online platform were shown to them during the follow-up interviews. The recordings provided the researcher/instructor with a visual representation of the learners' actions and decisions as they addressed the provided AWCF.

Each interview took an average of one hour and was recorded and accurately transcribed for subsequent data analysis. To increase the validity and reliability of the elicited stimulated recall data, a member checking technique (Creswell, 2007) was applied in which the recall transcripts were returned to the participating learners to check for accuracy and make alterations and/or modification, if needed. At the end of the stimulated recall sessions, the participating learners were debriefed about the study's purpose, procedures, and their role in the research. The learners were also given the opportunity to ask any questions and address any concerns they may have had.

3.4.3 Interview

To learn more about the attitudes and perceptions of the EFL learners towards the effectiveness of the AWCF, the same volunteered learners in the stimulated recall technique were individually interviewed. As the electronic learners outperformed their non-electronic counterparts in developing their writing skills, we further explored the electronic learners' writing performance to explain and clarify their more successful writing performance. That is, via examining the writing performance of the electronic learners, we sought to uncover specific aspects of their writing skills that were particularly influenced or facilitated by the utilisation of the AWCF platform. Interviewing the same participants who participated in the screencast session allowed for a more consistent and coherent analysis of the data. By comparing the learners' actions on the screencasts with their own recollections during the interviews, we were able to gain a deeper understanding of their cognitive, behavioural, and affective engagement with the AWCF. In addition, interviewing the same participants minimised the potential for extraneous factors to affect the data. This ensured that the comparisons were based on the learners' own experiences and perspectives, rather than any differences in familiarity with the task or the researcher/instructor's approach. Furthermore, interviewing the same learners fostered trust and rapport, which encouraged more open and honest responses and allowed for a more comprehensive understanding of their interactions with the AWCF.

A detailed examination of the literature constituted the foundation for the interview questions. To confirm the validity of the interview questions, the developed interview questions were submitted to several professionals and academic researchers in applied linguistics to make modifications, if necessary (see Appendix A for the interview questions). To effectively conduct the interviews, particular attention was given to handling unclear responses from the participating EFL learners. In case the learners' responses lacked clarity or required further elaboration, additional open-ended questions (in addition to the interview questions) were applied to encourage the learners to provide more detailed information. This approach aimed at obtaining a comprehensive understanding of the learners' attitudes and perceptions towards the effectiveness of the AWCF. A series of follow-up questions were also integrated into the interview process to extract more information and encourage the learners to elaborate on their initial responses. This technique not only allowed for the clarification of ambiguous information but also facilitated the exploration of unanticipated aspects related to the learners' engagement with the AWCF.

Each interview lasted around 30 min and was conducted in the learners' first language to come up with richer data. Specifically, the participating EFL learners whose native language was Kurdish were interviewed in Kurdish, whilst those whose native language was Persian were engaged in interviews conducted in Persian. This approach aimed to facilitate a more profound and nuanced exchange of thoughts, opinions, and experiences, allowing the participants to articulate their perspectives with ease and accuracy. After being recorded, transcribed, and translated into English, the transcripts of the interviews were returned to the participating EFL learners, following Creswell's (2007) member checking technique, to allow the participating learners to make any possible alterations and/or modifications on the one hand, and to ensure about the credibility of the collected data on the other hand. To protect the identities of the participating EFL learners, the same pseudonyms L1, L2, …, and L7 were applied.

3.5 Data analysis

3.5.1 Quantitative analysis

Using the Kolmogorov-Smirno test, the quantitative data (the continuous marks) for both the pre- and post-tests in both groups were found to be normal, and there were no outliers. As a result, using parametric tests of one-way between-groups analyses of covariance (ANCOVA), the electronic and non-electronic groups' writing performance was examined and compared to indicate a more effective instructional procedure in developing the EFL learners' academic writing skills (i.e. task achievement, coherence and cohesion, lexicon, and grammatical range and accuracy). According to Dörnyei (2007), pre-test marks can be adjusted using ANCOVA as covariates to account for any post-test variations.

3.5.2 Qualitative analysis

3.5.2.1 Language-related episodes To analyse the electronic learners' recall transcripts, the learners' language-related episodes (LREs) were identified. LREs are defined as "any portion of a dialogue in which students discuss the language they are using, inquire about it, or self- or peer-correct the language production" (Swain, 2001, p. 287). In the current study, the AWCF related to grammar, punctuation, spelling, and writing conventions on the second writing drafts were identified. To establish the inter-rater agreement of the emerging LREs, an independent domain expert, following Creswell and Miller (2000), examined the LREs of the electronic EFL learners. Having collaborated with the researcher/instructor in identifying LREs, the interrater agreement in detecting LREs was 0.96.

Measuring behavioural engagement was crucial in understanding the extent to which the learners were actively involved in the AWCF process and engagingly applying the provided corrective suggestions. To measure behavioural engagement, we employed a combination of screencasts and stimulated recall interviews. The screencasts recorded the learners' actions as they addressed the AWCF, and the stimulated recall interviews allowed us to explore their thought processes and motivation behind their actions. A coding scheme was developed to categorise the learners' behaviours based on their responses to the AWCF. The identified LREs were codified to generate the error types the learners made, the number of times the learners accurately accepted and rejected the AWCF, and the number of times they inaccurately accepted and rejected the AWCF. The coding scheme included the following categories:

- *Accurately accepting AWCF*: The learner correctly accepts the AWCF and makes the necessary corrections based on the AWCF.
- *Accurately rejecting AWCF*: The learner correctly ignores the AWCF and makes a correction based on their own judgment without considering the AWCF.
- *Inaccurately accepting AWCF*: The learner makes a correction that does not fully address the error, either by making a surface-level change or by misinterpreting the AWCF.
- *Inaccurately rejecting AWCF*: The learner incorrectly ignores the AWCF, and requests clarification from the researcher/instructor or makes comments about the feedback.

Additionally, to find out about the learners' cognitive and affective engagement, the linguistic items in each LRE were sorted along with the researcher/instructor's query and the learner's response to the query to indicate how and why the learners were cognitively and affectively engaged with the AWCF. An experienced researcher independently coded 60 per cent of the data related to the three types of engagement. The inter-coder agreement for behavioural, cognitive, and affective engagement was 0.89, 0.81, and 0.86, respectively.

3.5.2.2 Thematic analysis Thematic analysis (Boyatzis, 1998) was utilised to analyse the semi-structured interview data using a bottom-up, iterative method. To this

end, the transcribed interviews were first codified using open thematic coding to identify the key themes regarding the attitudes and perceptions of the electronic learners towards the impact of the AWCF on their academic writing skills. Axial coding was followed by clustering the detected themes according to how they related to one another. That is, the researcher/instructor started to examine how the various codes identified during open coding were connected or related to each other, then similar or related codes were grouped together into clusters. The produced codes within each cluster were then labelled based on the subsumed themes in each cluster. The labelling step provided a concise and meaningful description of the connections and relationships identified through axial coding, and allowed us to communicate the core findings in a more accessible way. The following excerpt from one of the learner's transcripts, for instance, indicates how the data were codified, clustered, and labelled:

(1) This online platform allowed me to select one of the British, American, Australian, or Canadian English varieties, which helped me write more consistently. (2) In a sense, I can say that I got addicted to this online platform…… I knew that I received quick feedback, and it helped me get more familiar with my mistakes and weaknesses, and I learned not to repeat them next time.

As evident, the transcribed excerpt was broken down into two excerpts. Excerpt 1, showing the platform's affordance in allowing the learner to pick their own English variety, was clustered in the "allowing for English varieties" theme under the "producing effective writing" category. Excerpt 2, indicating the learner's satisfaction with the platform's affordance in dealing with their writing weaknesses, was clustered in "pinpointing writing weaknesses" under the "self-regulating writing" category. Table 1 also provides a succinct yet comprehensive overview of our structured coding process for an uncovered category, including its related themes.

Inter-rater reliability was applied for the open coding, axial coding, and labelling processes (Gass & Mackey, 2000). In addition to the researcher/instructor, a second experienced researcher thoroughly reviewed the open coding, axial coding, and labelling processes, and any discrepancies were resolved through discussion.

4 Results

4.1 The quantitative analysis

Descriptive statistics were initially applied to show the EFL learners' pre- and post-test mean scores in writing performance, task achievement, coherence and cohesion, lexicon, and grammatical range and accuracy in both the electronic and non-electronic groups. The results of the descriptive statistics are demonstrated in Table 2.

Table 2 indicates subtle differences between the two groups' pre-test mean scores regarding their writing performance, task achievement, coherence and cohesion, lexicon, and grammatical range and accuracy. However, there was some development in the two groups' pre-test to post-test mean scores on the one hand, and between the post-test mean scores of both groups on the other hand.

Table 1 Sample coded texts, showing the essence of each identified theme

Coding process	Sample coded texts	Examples
Open thematic coding	Giving immediate feedback	L5: *I liked it and it was a cool experience since I could check my sentences and get quick feedback. After a while, I realised my common mistakes, and it helped me correct some old mistakes.*
	Pinpointing writing weaknesses	L5: *In a sense, I can say that I got addicted to this online platform…… I knew that I received quick feedback, and it helped me get more familiar with my mistakes and weaknesses, and I learned not to repeat them next time.*
	Providing explanations	L5: *The online platform provided simple and useful explanations and examples, which further helped me develop my writing skills.*
	Self-revising writing	L1: *It was interesting that I could self-revise my written texts quickly and effectively.*
	Boosting self-confidence	L1: *I can say it increased my self-confidence and motivation in writing because I knew that my glaring mistakes were checked.*
Axial coding (Grouping themes)	1. Pinpointing writing weaknesses 2. Self-revising writing 3. Boosting self-confidence	
Theme categorisation	Self-regulating writing	

Table 2 Descriptive statistics of pre- and post-test marks

	Group	*N*	Mean	Std. deviation	Std. error mean
Pre-writing performance	Electronic	30	4.32	0.94	0.17
	Non-electronic	26	4.27	0.91	0.18
Post-writing performance	Electronic	30	5.88	1.08	0.19
	Non-electronic	26	4.86	1.00	0.19
Pre-task achievement	Electronic	30	3.43	0.81	0.14
	Non-electronic	26	3.65	0.78	0.15
Post-task achievement	Electronic	30	5.13	1.27	0.23
	Non-electronic	26	4.66	1.07	0.21
Pre-coherence and cohesion	Electronic	30	4.03	0.80	0.14
	Non-electronic	26	3.88	0.85	0.16
Post-coherence and cohesion	Electronic	30	5.19	0.72	0.13
	Non-electronic	26	4.89	1.06	0.20
Pre-lexicon	Electronic	30	4.37	1.05	0.19
	Non-electronic	26	3.91	1.27	0.24
Post-lexicon	Electronic	30	5.73	1.02	0.18
	Non-electronic	26	5.26	1.36	0.26
Pre-grammatical range and accuracy	Electronic	30	3.64	0.70	0.12
	Non-electronic	26	3.81	0.77	0.15
Post-grammatical range and accuracy	Electronic	30	6.02	1.25	0.22
	Non-electronic	26	4.33	1.02	0.20

One-way ANCOVA was run to examine whether there were any significant differences between the electronic and non-electronic classes in developing the EFL learners' writing performance, task achievement, coherence and cohesion, lexicon, and grammatical range and accuracy. First, one-way ANCOVA was used to examine the differences between the two groups' writing performance, the results of which are presented in Table 3.

As indicated in Table 3, after controlling for the pre-test marks as the covariates, there were significant differences between the two groups' post-test marks of writing performance, confirming that the electronic EFL learners outperformed their non-electronic counterparts in developing writing performance [$F(1, 53)=47.29$, $p<0.00$, $\eta_p^2=0.47$].

One-way ANCOVA was also used to examine the differences between the two groups' task achievement, after conducting the treatment. The results are shown in Table 4.

Table 4 shows that after controlling for the pre-test marks, there were significant differences between the two groups' post-test marks of task achievement [$F(1, 53)=3.73$, $p<0.05$, $\eta_p^2=0.06$], signifying that the electronic learners were more successful than the non-electronic learners in developing their task achievement.

One-way ANCOVA was further run to examine the two groups' differences in developing coherence and cohesion, the results of which are demonstrated in Table 5.

Table 5 indicates that there were no significant differences between the two groups' post-test marks of coherence and cohesion, after controlling for the pre-test marks

Table 3 ANCOVA, examining the differences between the two groups' writing performance

Source	Type III sum of squares	df	Mean square	F	Sig.	Partial eta squared
Pre-writing performance (covariates)	44.00	1	44.00	155.81	0.00	0.74
Groups	13.35	1	13.35	47.29	0.00	0.47

Table 4 ANCOVA, examining the differences between the two groups' task achievement

Source	Type III sum of squares	df	Mean square	F	Sig.	Partial eta squared
Pre-task achievement (covariates)	9.73	1	9.73	7.77	0.00	0.12
Groups	4.67	1	4.67	3.73	0.05	0.06

Table 5 ANCOVA, examining the differences between the two groups' coherence and cohesion

Source	Type III sum of squares	df	Mean square	F	Sig.	Partial eta squared
Pre-coherence and cohesion (covariates)	30.36	1	30.36	118.87	0.00	0.69
Groups	0.36	1	0.36	1.43	0.23	0.02

Table 6 ANCOVA, examining the differences between the two groups' lexicon

Source	Type III sum of squares	df	Mean square	F	Sig.	Partial eta squared
Pre-lexicon (covariates)	26.12	1	26.12	27.25	0.00	0.34
Groups	0.45	1	0.45	0.47	0.49	0.00

Table 7 ANCOVA, examining the differences between the two groups' grammatical range and accuracy

Source	Type III sum of squares	df	Mean square	F	Sig.	Partial eta squared
Pre-grammatical range and accuracy (covariates)	28.81	1	28.81	35.04	0.00	0.39
Groups	47.16	1	47.16	57.36	0.00	0.52

[$F(1, 53)=1.43$, $p<0.23$, $\eta_p^2=0.02$]. This corroborated no significant differences between AWCF and WCF in developing EFL learners' coherence and cohesion.

One-way ANCOVA was also applied to examine the differences between the two groups' lexicon, after conducting the treatment. The results are presented in Table 6.

Table 6 shows that after controlling for the pre-test marks, there were no significant differences between the two groups' post-test marks of lexicon [$F(1, 53)=0.47$, $p<0.49$, $\eta_p^2=0.00$], confirming no significant differences between AWCF and WCF in developing the EFL learners' lexicon.

Finally, one-way ANCOVA was used to examine the differences between the electronic and non-electronic groups' grammatical range and accuracy. The results are displayed in Table 7.

Table 7 reveals that after controlling for the pre-test marks, there were significant differences between the two groups' post-test marks of grammatical range and accuracy [$F(1, 53)=57.36$, $p<0.00$, $\eta_p^2=0.52$], corroborating that the electronic learners were more successful than their non-electronic counterparts in developing grammatical range and accuracy.

4.2 The qualitative analysis

4.2.1 Learner engagement

Exploring the electronic EFL learners' engagement with the AWCF by applying a stimulated recall technique, the findings showed that the electronic learners were behaviourally, cognitively, and affectively engaged with the AWCF, which could be supportive of the quantitative findings. The findings related to the learners' behavioural, cognitive, and affective engagement are presented next.

4.2.1.1 Behavioural engagement The learners' behavioural engagement was checked based on their screencasts and LREs. The error types were identified and classified following the accuracy and inaccuracy of the AWCF the learners received, and the

actions they took to respond to the AWCF (i.e. accepting or rejecting AWCF). Table 8 indicates all seven learners' revision operations in response to the AWCF.

As evident in Table 8, the learners made 152 errors for which they received AWCF. Twelve error types were recognised in the learners' writing drafts, comprising errors in the use of articles (34), spelling (21), writing conventions, such as capitalisation, spacing, and dialect-specific spelling (16), part of speech (14), verb form (13), punctuation (10), subject-verb agreement (9), relative clause (9), word choice (8), preposition (8), tense (6), and active/passive verb (4). Of 152 AWCF, the learners accurately accepted 85 and rejected 16 AWCF, and they inaccurately accepted 36 and rejected 15 AWCF. Having addressed 55.92 per cent of the total errors, the learners were thought to be behaviourally engaged with the AWCF.

4.2.1.2 Cognitive engagement As for the learners' cognitive engagement, each learner's recall transcript was segmented into LREs. The researcher/instructor's queries and each learner's responses related to the linguistic segments were arranged in a table to clarify the learner's cognitive engagement. Table 9, for instance, demonstrates an example of L3's cognitive engagement with the AWCF.

Cognitive engagement was conceptualised as the learners' noticing and understanding of AWCF. This could encompass the learners' use of cognitive processes to process feedback and decide on suitable revisions, as well as their metacognitive processes to control their mental effort. As evident in Table 9, L3 could easily recognise the online platform's feedback and suggestions as the errors and mistakes were underlined and coloured. As asserted, L3 could detect almost all the AWCF, understood the cause of the errors and mistakes, accepted all the AWCF, and knew how to correct the errors and mistakes, which suggests L3's cognitive engagement with AWCF at the level of noticing and understanding. However, not all the AWCF was

Table 8 All learners' behavioural engagement with AWCF

Error type	AWCF frequency	Accurate AWCF		Inaccurate AWCF	
		Accept	Reject	Accept	Reject
Tense	6	4	1	1	
Verb form	13	6	1	4	2
Subject-verb agreement	9	4	1	3	1
Word choice	8	3	1	3	1
Articles	34	11	4	15	4
Part of speech	14	5	3	3	3
Active/Passive verb	4	2	1	1	
Relative clause	9	6	1	1	1
Spelling	21	17	1	1	2
Punctuation	10	8	1	1	
Preposition	8	7		1	
Writing conventions	16	12	1	2	1
Total number of errors	152	85	16	36	15
Percentage	100%	55.92%	10.53%	23.68%	9.87%

Table 9 L3's cognitive engagement with AWCF

Sample LRE	Query	Response
However=However,	You accepted this corrective feedback and applied it, why?	*Actually, I had already studied contrast words and I knew that we should use a comma after "however". When I saw the online feedback, I quickly accepted that I had made a mistake.* (L3)

Table 10 L6's cognitive engagement with AWCF

Sample LRE	Query	Response
A bulk of studies has explored=A bulk of studies have explored	You rejected this corrective feedback and did not apply it, why?	*The feedback provided by the online platform was saying "has should become have" …… but this feedback was surprising to me because the subject is "a bulk" which requires a singular verb! So, I did not apply this feedback.* (L6)

noticed, understood, and resolved by all the learners. For example, Table 10 reveals how L6 decided not to alter the written sentence.

Table 10 shows that the feedback given by the online platform was not understood by L6, and the sentence was not altered whatsoever. It is obvious that L6 could easily and quickly identify the corrective intention of the provided feedback; however, L6 did not understand the nature of the feedback due to their lack of knowledge in that regard. It may thus be proposed that L6 was cognitively engaged with AWCF at the level of noticing, but not understanding.

4.2.1.3 Affective engagement Similarly, regarding the learners' affective engagement, the segmented linguistic items along with the researcher/instructor's questions and the learners' responses were sorted in a table to reveal the learners' affective engagement. Table 11 presents an example of L1's affective engagement with the AWCF.

Affective engagement was conceptualised as the learners' attitudes and emotional reactions towards AWCF. Considering the example in Table 11, L1 was passionate about the AWCF provided by the online platform because, as pointed out, AWCF helped L1 correct the errors very simply. L1 would also apply the online platform in future writing tasks since the AWCF given by the online platform was a contributing factor to L1's writing development. It is argued that L1 considered the AWCF authoritative and indispensable for addressing language-related errors and mistakes in their written texts. Although it was the first time L1 used an online platform for its AWCF, L1 was positive about what the online platform recommended. It could therefore be suggested that L1 was affectively engaged with the AWCF. However, some of the

Table 11 L1's affective engagement with AWCF

Sample LRE	Query	Response
bored from = bored with	You accepted this corrective feedback and applied it, why?	*I came to realise that I had used the wrong preposition! Something which has been my old weakness in writing. And now, I appreciate the AWCF; I have got much better at using prepositions.* (L1)

Table 12 L4's affective engagement with AWCF

Sample LRE	Query	Response
means of transportation = the means of transportation	You rejected this corrective feedback, why?	*To the best of my grammar knowledge, I do not use "the" if I use the words in their general sense. So, I rejected this suggestion. I have seen that the default setting of this online platform is just to put "the" everywhere!* (L4)

learners revealed their negative affective engagement with the AWCF. For instance, Table 12 provides an example of L4's affective engagement with the AWCF.

Table 12 indicates that L4 was unsure about the online platform's redundant feedback on the linguistic item "the". This was due to the fact that L4 deemed some AWCF inappropriate and unnecessary to address. L4's behavioural and cognitive engagement were affected by such emotional reactions of uncertainty about the AWCF, demonstrating the interconnectedness of the three dimensions of engagement. Although L4 was reluctant to address some AWCF provided by the online platform, L4 found some feedback useful for addressing the errors and mistakes and developing their writing drafts. This shows that L4 was not very supportive of the AWCF when they found the feedback inaccurate; however, addressing some feedback indicated corroborative evidence of L4's affective engagement with some AWCF.

4.2.2 Learner perceptions

4.2.2.1 Positive learner perceptions Corroborating the aforementioned quantitative and qualitative findings, the electronic EFL learners also highlighted the positive role of the AWCF in developing their academic writing skills. Figure 4 presents the uncovered themes and categories in this regard.

As evident in Fig. 4, four categories along with 16 themes were uncovered addressing the EFL learners' positive attitudes and perceptions towards the electronic class. The first group of themes revolved around the role of the AWCF in developing EFL

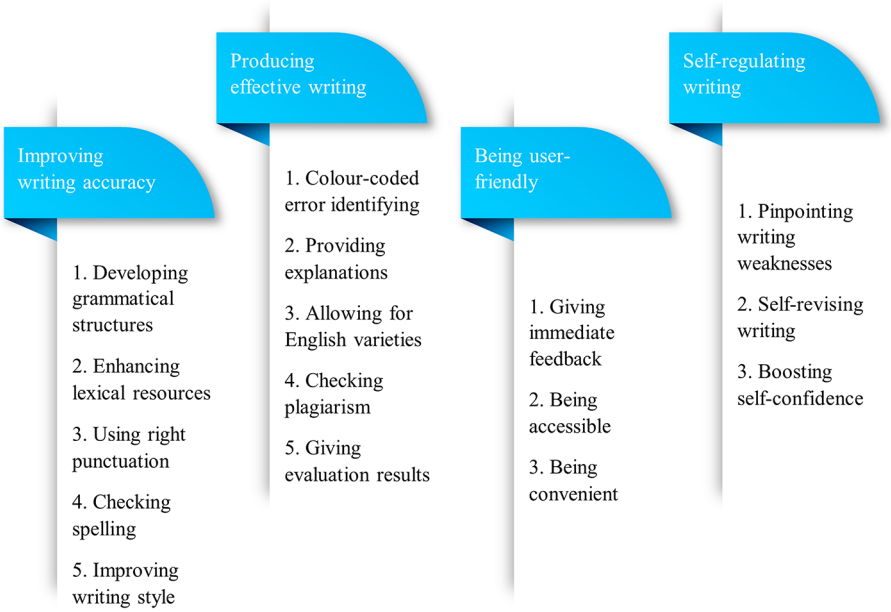

Fig. 4 Uncovered positive themes and categories towards AWCF

learners' writing accuracy. The EFL learners, for example, highlighted the role of the AWCF provided by the online platform in developing their grammatical range and accuracy since it provided more accurate and suitable structures for their sentence construction. The learners claimed that the provision of feedback and suggestions related to grammatical structures facilitated their exposure to a diverse range of grammatical forms. Such feedback and suggestions played a crucial role in not only identifying their potential grammatical errors and mistakes but also in providing constructive alternatives and, hence, expanding their knowledge of sentence structures. L6, for example, asserted that:

> It gave me suggestions regarding grammatical structures, and this helped me get exposed to various grammatical structures.

The learners also thought that the online platform expanded their vocabulary knowledge by providing synonyms and suggested words for their writing. The learners expressed that the platform facilitated a more accessible and effective method of learning new words by automatically providing specific instances of vocabulary items for their writing. The platform not only corrected the lexical items of the learners' writing but also instructively expanded the learners' lexical range, making the vocabulary learning process more efficient and learner-friendly. L7, in this line, suggested that:

> I used to search for synonyms using different dictionaries, but this online platform suggested synonyms which were more easily learned in this way.

The learners further stated that the electronic course developed their use of punctuation in their writing drafts since they were immediately provided with the correct punctuation whenever they made a mistake or error. The learners acknowledged that the real-time punctuation correction and guidance offered by the AWCF platform contributed positively to their understanding and application of punctuation rules. For instance, L2 mentioned that:

> I have never been good at English punctuation, but this course was effective in helping me develop my punctuation.

Additionally, the learners highlighted the role of the AWCF in addressing the spelling issues in their writing, which could be set in one of the English varieties (e.g. British or American English). In addition to the learners' grammatical accuracy, the AWCF served as a valuable resource for learners seeking development in the intricacies of English spelling. In this regard L1 stated that:

> The online platform was more useful for grammar, although it helped me correct my spelling regarding the use of a variety of vocabularies.

Finally, the aforementioned group of themes focused on the role of AWCF in enhancing the EFL learners' writing style, such as learner tone and voice and word choice. Despite the contribution of the AWCF to grammatical and lexical areas of writing, the AWCF was believed to be also a valuable resource for developing the detailed and subjective aspects of writing style. This contributed to the incorporation of a distinctive tone and voice in the learners' written texts. L4, for example, contended that:

> The online platform …. was very good because it also helped correct writing style issues.

As indicated in Fig. 4, the second group of themes focused on some affordances of the online platform, which contributed to more effective writing. The learners, in this regard, highlighted the colour-coded error identification affordance of the online platform that could help them identify the type of language-related writing issues and address them appropriately. The distinct colour scheme with red highlighting grammar, punctuation, and spelling issues, blue addressing language clarity and conciseness, purple signalling sentence formality and politeness issues, and green encouraging more engaging sentence structures, showcased a comprehensive approach to writing feedback. The learners argued that the colour-coded system contributed not only to language error identification but also to a deeper understanding of diverse language aspects. L6 said that:

> I enjoyed its colour-coded error identification function. A red line showed grammar, punctuation, and spelling issues, blue showed issues related to our language clarity and conciseness; purple indicated issues related to our sentence formality and politeness, and green allowed us to apply more engaging sentences in our writing.

The online platform also provided the required explanations for each feedback which contributed to the learners' better understanding of the feedback on the one hand, and saved the researcher/instructor's time to teach the learners other writing issues on the other hand. The use of clear and accessible explanations with illustrative examples created a supportive learning environment, and enabled the learners to comprehend the details of the writing corrections offered by the platform. The learners also thought that this time-saving affordance helped them immediately address and rectify their writing issues without the need for extensive instructor intervention. It further allowed the researcher/instructor to have a more focused and efficient teaching of other writing-related aspects. L5 pointed out that:

> The online platform provided simple and useful explanations and examples, which further helped me develop my writing skills.

The learners could also select one of the English varieties of British, Australian, American, or Canadian and adjust the online platform's feedback accordingly to write more consistently and effectively in one English variety. The learners could follow specific linguistic norms, such as British spelling, vocabulary, and grammatical structures. This allowed the learners to produce written content that was not only accurate but also consistent and contextually appropriate based on the selected English variety. L7, for instance, expressed that:

> This online platform allowed me to select one of the British, American, Australian, or Canadian English varieties, which helped me write more consistently.

The online platform further checked for plagiarism in the learners' writing drafts, which could also contribute to their writing effectiveness. This affordance helped the learners avoid unintentional plagiarism and foster a more ethical writing practice. This highlighted the platform's impact on both language correction and broader considerations of academic rigour and authenticity in the learners' writing performance. L3 added that:

> One of its good features is its ability to check plagiarism, which can help us as far as academic writing is concerned.

At the end of each writing draft, the online platform provided the learners with the evaluation results of their writing, which further helped the learners develop their writing performance. The evaluation results offered the learners insights into their writing strengths and the writing areas requiring development, which highlighted its commitment to fostering clarity in the learners' writing evaluation process. L3, for instance, maintained that:

> The online platform was great. I could easily download the evaluation results related to my writing.

The other category revolved around the user-friendliness of the AWCF provided by the online platform. The EFL learners, for instance, stated that they could receive feedback and related explanations immediately to develop their writing drafts. The immediate nature of the feedback helped the learners address specific writing issues on the one hand, and contributed to an ongoing process of self-correction on the other hand. L5 mentioned that:

> I liked it and it was a cool experience since I could check my sentences and get quick feedback. After a while, I realised my common mistakes, and it helped me correct some old mistakes.

The accessibility of the current online platform anywhere and anytime was further appreciated by the learners. The accessibility of the online platform was specifically highlighted when the learners knew that some online programmes were inaccessible in the present context. This accessibility is particularly valued in the context of financial constraints like the present context, where the platform's free nature was a distinct advantage. L6, for example, pointed out that:

> I appreciate this free online platform, which can be used anywhere, especially in this context where students do not have access to programmes or software that are not free.

In addition to accessibility, the online platform was also convenient for the learners, as they could easily create an account and, using the affordances, do their writing tasks following the feedback. This highlighted the convenience of AWCF in contributing to the learners' writing skills on the one hand, and providing a positive and convenient learning environment on the other hand. L7 highlighted that:

> One key merit of this online platform is its convenient access…… we could easily create an account, submit our writing, and receive quick feedback.

The AWCF also contributed to the learners' autonomous writing. As the learners claimed, the online platform helped them recognise their writing weaknesses, and act accordingly to develop their academic writing skills. That is, the learners' ability to recognise and realise their writing weaknesses through immediate feedback empowered them to take charge of their writing tasks more effectively. Pinpointing writing weaknesses by the online platform and the provision of immediate and relevant feedback, contributed to reflective and self-regulatory dimensions of the learners' writing engagement. L5 expressed that:

> In a sense, I can say that I got addicted to this platform…… I knew that I received quick feedback, and it helped me get more familiar with my mistakes and weaknesses, and I learned not to repeat them next time.

The learners asserted that at the subsequent stages of the electronic writing course, they could autonomously revise their writing drafts due to the AWCF received from

the online platform. This revealed a shift from conventional reliance on instructors or peers for writing feedback to a more self-directed and efficient revision process. L1, in this regard, argued that:

> It was interesting that I could self-revise my written texts quickly and effectively.

The learners added that they were more confident in accomplishing their writing tasks in future courses. This highlighted that the AWCF not only served as a platform for the learners' immediate writing development but also had long-term positive effects on their writing confidence, which capitalised on the psychological benefits of the AWCF. L1 added that:

> I can say it increased my self-confidence and motivation in writing because I knew that my glaring mistakes were checked.

In general, the electronic EFL learners thought that the AWCF of the online platform substantially contributed to their writing performance in general and writing accuracy in particular. Such positive attitudes and perceptions might be a reason behind the EFL learners' higher development in writing performance and writing accuracy.

4.2.2.2 Negative learner perceptions Some of the electronic EFL learners also highlighted some issues related to the AWCF. The uncovered themes and categories in this regard are demonstrated in Fig. 5.

As shown in Fig. 5, two categories and six themes were uncovered about the EFL learners' negative attitudes and perceptions towards the AWCF. The first group of themes addressed the learners' negative attitudes and perceptions towards the lower-order feedback provided by the online platform. For example, the learners mentioned that the online platform's feedback only revolved around some surface structures and other lower-order grammatical points, which did not have a major contribution to their writing performance. L2, for instance, stated that:

> The focus of this online platform is just on form and surface structure…. it cannot develop writing ….it is only useful as far as limited sentence structures are concerned.

The learners thought that complex sentences, which could positively contribute to their writing drafts, were not adequately checked by the online platform. This highlighted a potential limitation in the platform's ability to comprehensively assess and develop the complexities of sentence structures, which was perceived by the learners as a critical aspect of advanced writing skills. L5, in this regard, mentioned that:

> I think it is not a very useful online platform for complex sentences…… to me, it was simply a grammar checker!

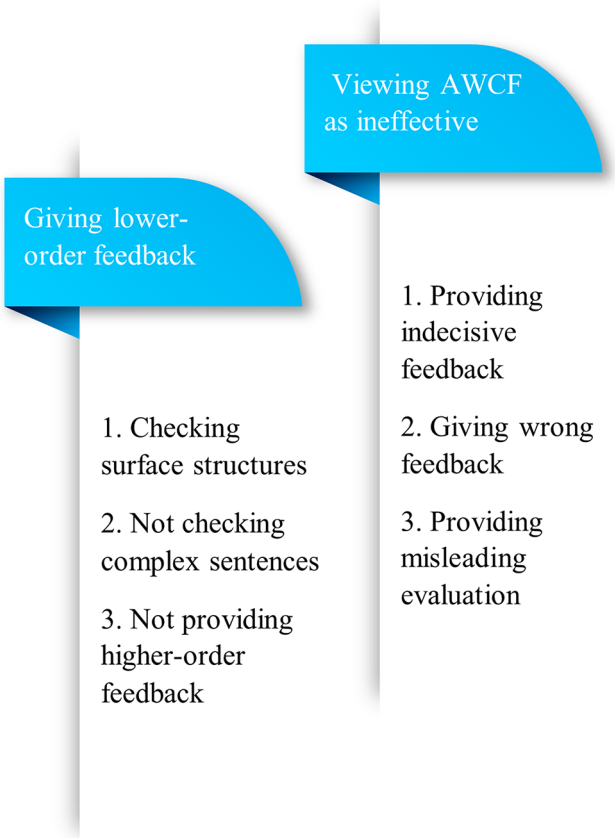

Fig. 5 Uncovered negative themes and categories towards AWCF

Additionally, higher-order feedback was not provided to address other more important elements of their writing, such as writing content and writing organisation. The learners thought that the provision of comprehensive feedback, encompassing writing content, writing organisation, and idea coherence, could significantly contribute to their overall writing development. However, the learners claimed that the platform lacked more advanced elements of writing feedback, beyond basic grammatical aspects. L2 added that:

> My main weakness in writing is producing coherent and well-connected sentences. This online platform was not effective in this regard as it could not help me with my writing content, organisation, and ideas effectively …. it checked only simple grammar, not the content!

It could thus be argued that a part of the learners' negative attitudes and perceptions towards the AWCF came from the type of feedback provided by the online platform, which they thought was not highly effective in developing their writing skills.

The second group of themes concentrated on the learners' attitudes and perceptions towards the ineffectiveness of the online platform's feedback. The learners, for example, insisted that the provided feedback by the online platform was not straightforward, and they had to search for other resources to find which suggested feedback was appropriate for their writing. This capitalised on the importance of clear and user-friendly feedback for learners to feel confident in implementing writing corrections. L6, for example, proposed that:

> The online platform usually provides us with suggestions, and leaves the final decision regarding implementing the corrections to the user …. this gives me a sense of lack of assurance.

The learners maintained that some of the feedback was wrong, and neither contributed to their writing drafts nor their writing skills. This raised concerns about the effectiveness and trustworthiness of the automated feedback since inaccuracies of the feedback could potentially hinder their understanding and writing development. L2 maintained that:

> Some of the feedback was wrong and misleading.

Finally, the learners asserted that the evaluation results provided by the online platform were not particularly helpful as they only capitalised on the language-related issues, which were not their writing concern. The learners highlighted the deficiency of the evaluation results in addressing a comprehensive range of writing issues, beyond language-related issues. This emphasised the importance of developing the evaluation criteria to ensure that they deal with learners' various writing needs. L3 argued that:

> I think some evaluations and suggestions of this online platform were not accurate.

The aforementioned learners' negative attitudes and perceptions might be generally due to their preferences to receive feedback on their major writing issues, which they thought were their writing concerns neglected by the online platform.

5 Discussion

Drawing on Engeström's (1987) activity theory, the current study examined the impact of AWCF in an electronic class and WCF in a non-electronic class on EFL learners' academic writing skills. The findings revealed that both electronic and non-electronic classes enhanced the EFL learners' academic writing performance. Additionally, the findings revealed that the electronic writing course outperformed its non-electronic counterpart in developing the academic writing performance of the EFL learners. The findings are consistent with those of Cheng (2017) and Tan et al. (2022), who revealed the effectiveness of AWCF via an online platform in enhancing English

language learners' writing performance, especially writing accuracy. As supported by Barrot's (2023) findings, the findings in this study were due to the efficiency of the online platform in providing the learners with appropriate feedback. That is, the learners were immediately given appropriate feedback about their language-related issues, which positively affected their writing performance. Additionally, following Barrot (2023), as the online platform gave the learners immediate and synchronous metalinguistic explanations along with the AWCF, the learners could better notice and realise their errors and mistakes and, hence, develop their writing performance more effectively. On the other hand, the non-electronic learners received the related WCF after accomplishing their writing drafts, which did not affect the non-electronic learners' writing drafts as effectively as AWCF in the electronic class. Furthermore, due to the time limitation in the non-electronic class, the non-electronic learners were provided with metalinguistic explanations after their writing tasks.

Concerning the academic writing skills, the findings indicated that the electronic class outperformed the non-electronic class in developing the EFL learners' task achievement and grammatical range and accuracy; however, no significant differences were found between the two groups' coherence and cohesion and lexicon. Waer (2023), in much the same vein, confirmed that EFL students receiving online feedback outperformed students receiving feedback in the paper-based format in grammatical range and accuracy. This draws attention to the fact that providing immediate corrective feedback electronically contributed to the EFL learners' higher achievement in writing accuracy since, as corroborated by Tan et al. (2022), the learners synchronously received AWCF whilst doing and revising their writing drafts and addressed their writing issues immediately, which could help them develop their writing accuracy. As for the task achievement skill, which deals with the relevance of the total meaning of the writing to the writing topic, it is argued that the efficiency of the online platform in providing the AWCF saved more time for the electronic learners to attend to other higher-order matters of their writing draft, such as task achievement, and accomplish their writing drafts more appropriately. Consistent with the findings, Warschauer and Grimes (2008) and Wilson and Czik (2016) argue that by relying on an online platform for providing English language learners with AWCF, teachers can better concentrate on learners' major writing issues and contribute to their writing more appropriately. Yet, the time limitation in the non-electronic class did not allow the learners to adequately concentrate on different writing skills, like grammatical range and accuracy and task achievement.

The aforementioned quantitative findings could be related to the nature of the AWCF provided by the online platform, which allowed the electronic learners to develop their academic writing skills. Following Barrot (2022), the learners in this study were engaged with the AWCF as the online feedback was provided immediately using different affordances of the online platform, such as underlining various errors with different colours, which made it convenient for the learners to address the provided feedback. The online platform also provided a user-friendly environment for the electronic learners to apply the AWCF appropriately and enhance their academic writing skills more effectively. Although the online platform's feedback revolved around writing accuracy, the efficiency and effectiveness of the AWCF helped the electronic learners develop their writing accuracy and saved more time

for other higher-order writing feedback provided by the researcher/instructor, which helped the learners develop other writing skills likewise. In line with Koltovskaia's (2020) findings, in the current study, using the linguistic explanations of the online platform which were provided along with the AWCF, made the learners search for other related resources and examples online, which further contributed to the learners' academic writing skills. Additionally, the learners addressed the AWCF synchronously, which allowed the learners to think more extensively and deeply about the provided feedback.

Following Engeström's (1987) activity theory, the online platform, as the mediation artefact, substantially contributed to the electronic learners' successful writing performance. By highlighting language-related and writing convention-related issues and giving the related metalinguistic explanations, the online platform provided additional insights into the learners' language errors and writing areas. This signified that the online platform regulated the learners' academic writing skills by giving them the necessary AWCF and helping them internalise their writing capabilities. The community also provided a convenient social setting for the learners' interactive writing activities by allowing them to share their writing ideas with their peers and collaboratively work on their writing revisions. The use of technologies also engaged the learners in further other-regulated language writing activities. Receiving feedback from technological sources contributed to the learners' profound understanding of the academic writing skills and other-regulated writing engagement, which could subsequently contribute to their academic writing skills.

The online platform also helped the electronic learners gradually move from the other-regulated writing activities with the online artefact to the self-regulated writing activities, in which they could take care of their writing tasks autonomously, findings which were in harmony with Engeström's (1987) activity theory. The electronic learners who regulated their academic writing skills were able to independently accomplish their writing tasks without the contribution of the online platform. This corroborated that the electronic learners who utilised the AWCF could achieve their writing self-regulation or automatisation more effectively and efficiently than their non-electronic counterparts who only utilised the WCF. Such findings were consistent with the qualitative findings of the study in which the learners asserted that the AWCF contributed to their self-regulated writing activities. Figure 6 demonstrates the complex activity system of the electronic learners, which indicates no tensions among the dimensions, leading to the learners' self-regulation or automatisation in writing.

As shown in Fig. 6, the online platform served as a powerful mediational artefact that connected the electronic learners with the AWCF and the writing activities. The rules which guided the interactive writing activities were affected by the norms and expectations set by the online platform, which in turn were guided by the learners' satisfaction. The AWCF also strengthened the community connection by fostering a shared environment for the learners, the researcher/instructor, and the class environment. The roles and responsibilities within the electronic group were distributed in a way that positively affected the learners' writing objective (i.e. self-regulation or automatisation in writing). Such strong connections among various dimensions of the activity system in the electronic class significantly contributed to the learners'

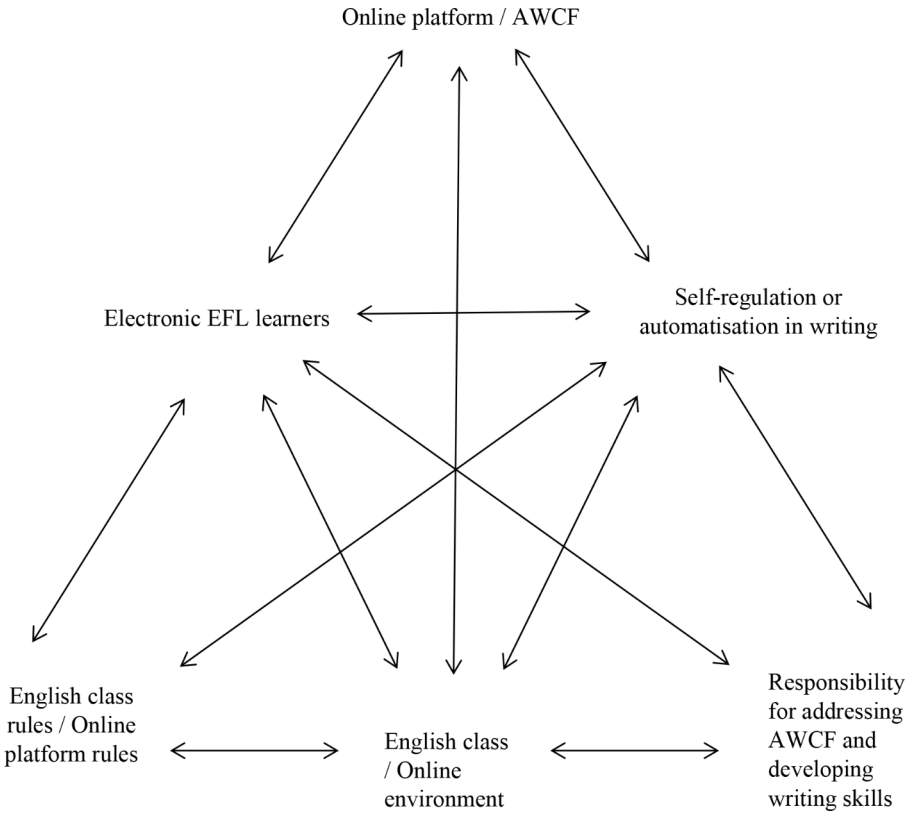

Fig. 6 Complex model of the activity system of the electronic group

self-regulation or automatisation of writing. Despite Fig. 6 which indicates a lack of tension among different dimensions of the activity system in the electronic class, some tensions were identified among some activity system's dimensions in the non-electronic class. Figure 7 shows the complex activity system of the non-electronic learners, which indicates some tensions among some activity system's dimensions.

The dotted lines in Fig. 7 indicate that there were tensions among some dimensions of the activity system in the non-electronic group, when compared to the electronic group. For example, some tensions were observed between the EFL learners and the WCF, which led to the learners' lower writing achievement in comparison with the electronic learners. In the non-electronic group, the mediational artefact was the WCF that lacked the immediacy and automation of the AWCF, and resulted in a comparatively weaker connection between the non-electronic learners and the mediational artefact and, hence, their writing objective (i.e. self-regulation or automatisation in writing). Moreover, the lack of time to engage in interactive writing activities in the classroom created some tensions between the learners' interactive writing activities with the other peers and the English class environment. In the non-electronic class, the division of labour might have also been more conventional since the researcher/instructor took the central role rather than an online platform, which resulted in a

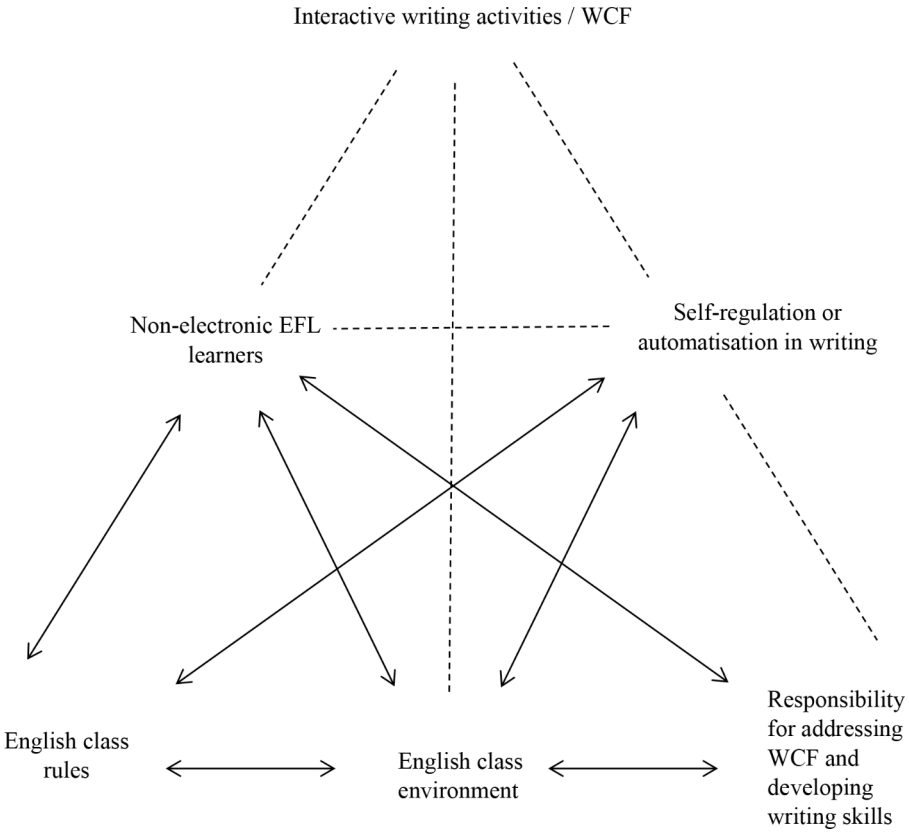

Fig. 7 Complex model of the activity system of the non-electronic group

comparatively weaker connection in terms of roles and responsibilities. All the tensions between various dimensions of the activity system in the non-electronic class led to the non-electronic learners' lower writing performance in comparison with their electronic counterparts.

The qualitative findings, supporting the abovementioned quantitative findings, also revealed that the electronic EFL learners were behaviourally, cognitively, and affectively engaged with the AWCF. Low proficient learners would accept and address all the AWCF to develop their writing drafts. That is, such learners were engaged with the AWCF both behaviourally and affectively, which indicated the learners' willingness towards the effectiveness of the AWCF in developing their academic writing skills. Although, in line with Koltovskaia's (2020) findings, the learners mostly accepted the AWCF and revised their writing drafts accordingly, they would ignore addressing some feedback as they thought the feedback was either incorrect or impertinent. In harmony with the findings of Ranalli (2021), the findings of the present study indicated that the learners applied the online platform's AWCF, but did not apply all the AWCF to revise their writing drafts since their linguistic knowledge prompted them to think critically about the provided feedback. The findings, in this regard, were in agreement with those of Koltovskaia (2020), who found that students

effectively utilised AWCF. Some of the learners in this study would initially draw on their linguistic knowledge to address the AWCF, which sometimes resulted in rejecting accurate feedback. This was due to the electronic learners' development in academic writing skills, which made them search for various resources before addressing the AWCF. Such findings showed the learners' cognitive and affective engagement with the AWCF, which resulted in more cognitive and metacognitive processes and further emotional reactions. This also allowed the electronic learners to think more positively about the AWCF, and deeply process the AWCF at the level of noticing and understanding.

The qualitative findings further indicated that the electronic EFL learners mostly held positive attitudes and perceptions towards the impact of the AWCF on their academic writing skills. Tan et al. (2022), in a similar line, confirmed EFL learners' positive attitudes and perceptions towards AWCF. The interview findings likewise supported the aforementioned quantitative and qualitative findings of the study, as the electronic learners believed that the AWCF developed their writing performance and writing accuracy, such as grammar, punctuation, and spelling. In harmony with Barrot's (2022) findings, the learners in this study thought that the essential affordances of the online platform, such as colour-coded error identification, gave the learners abundant opportunities to address their writing issues and develop their writing skills. The affordances, which were highlighted by the electronic learners, were regarded as the main causes of the learners' writing development in the quantitative part of the study. The learners also appreciated the user-friendliness of the online platform, which they thought engaged them with the AWCF and the revision of their writing drafts. The user-friendliness of the online platform, therefore, contributed to the academic writing skills development of the learners, which was also supportive of the quantitative findings. The online platform gradually helped the learners' writing self-regulation, which as Fathi and Rahimi (2022) and Rahimi and Fathi (2022) claim, occurs after collaborative writing activities, when learners achieve their high writing competence. That is, reaching self-regulation in writing, as highlighted by the learners, was considered another indicator of the electronic learners' development in academic writing skills, which was further supportive of the quantitative findings.

6 Conclusion

Employing a mixed-methods approach for data collection and analysis, the current study revealed that the AWCF provided electronically was a more effective instructional procedure in comparison with the WCF provided non-electronically in developing the EFL learners' academic writing skills, including task achievement and grammatical range and accuracy. The electronic EFL learners were also behaviourally, cognitively, and affectively engaged with the AWCF, and held mostly positive attitudes and perceptions towards the AWCF. The findings recommend that EFL instructors should conduct an AWCF-based course to enhance EFL learners' aforementioned academic writing skills more effectively. EFL learners are also suggested they apply different affordances of related online platforms to address AWCF more appropriately, and develop their academic writing skills more effectively. As some

affordances of the online platform, such as colour-coded error identification, adaptive metalinguistic explanations, and the immediacy in the AWCF provision, were proven to contribute to the learners' writing performance during the second writing draft phase, the online platform could be applied in process-based writing courses, especially when learners revise and edit their writing drafts.

To benefit more from AWCF provided by online platforms, EFL instructors need to provide EFL learners with appropriate guidance and training on how to effectively deal with AWCF. Initially, EFL learners' affective engagement with AWCF needs to be enhanced to properly engage them with AWCF. Instructors should also inform learners of the inaccuracy of some of the online platform's feedback to avoid excessive reliance on AWCF. EFL learners also need to critically question and analyse the feedback provided by the online platform to enhance their cognitive engagement with AWCF on the one hand, and accurately apply the correct feedback and reject the incorrect feedback on the other hand. This can signify that AWCF mostly benefits intermediate and advanced EFL learners as they can criticise and address the feedback more effectively than beginners. As for the behavioural engagement with AWCF, EFL learners are suggested to confirm the provided feedback with other online resources, peers, and instructors.

As some of the EFL learners in the present study raised doubt about some AWCF which was given by the online platform due to the online platform's perceived shortcomings, AWCF is encouraged to be supported and checked by instructors as well so that EFL learners can benefit more from AWCF-based courses. EFL learners are also encouraged not to blindly reject or accept AWCF since blind rejection or acceptance of AWCF may lead to moderate development in writing performance (Koltovskaia, 2020). The findings also call for the development and/or upgrading of AWCF-based platforms that may provide entirely accurate and particularly relevant AWCF. Furthermore, AWCF could be applied to other EFL writing courses, such as English for academic purposes, to contribute to EFL students' academic writing skills.

However, some limitations were recognised in the present study that need to be addressed by EFL researchers. The findings of the study, for instance, should be generalised with caution as there was a small sample size recruited in both the electronic and non-electronic classes. In addition, convenience sampling may not represent the broader population accurately. The findings may not be generalisable to all EFL learners as the sample was selected based on accessibility and convenience, which did not account for learner variations that could exist in a more heterogeneous population. EFL researchers need to replicate the current study, apply a large sample size, and adopt a different and more valid sampling strategy to generalise the findings with more confidence. In addition, the researcher/instructor's dual role as both the instructor and the researcher might have introduced the potential for bias. That is, the researcher/instructor's expectations or beliefs could affect how the study was conducted or how the learners responded to the written feedback. The learners may have responded to the corrective feedback in both groups in ways they perceived as socially desirable due to the researcher/instructor-learner relationship. The researcher/instructor's awareness of group assignments (electronic vs. non-electronic) also might have unintentionally affected the instructional approach or behaviour towards each group. Future researchers might consider using different instructors in both electronic and

non-electronic groups to control for their bias and explore their unbiased, non-dual effects on EFL learners' writing performance. Future studies might also implement measures to development the objectivity, such as using standardised assessments, blind grading, or involving an independent observer to minimise the experimenter effects.

Moreover, following the cultural context of the study, which was in a setting with limited technological integration in education, particularly for writing skills development, several recommendations for future research could be proposed. Firstly, future studies could explore the transferability of the positive impact of the AWCF observed in this study to more technologically advanced educational settings. Investigating whether similar writing development can be achieved in environments where technological platforms are already prevalent, would contribute to understanding the universality of AWCF efficacy. This study also did not extensively explore the multifaceted contextual or cultural dimensions that could potentially affect the findings. Future research should aim to encompass and address these vital variables for a more holistic analysis of the area. For example, future research might explore the adaptation of AWCF platforms to address the specific needs and preferences of learners in different cultural contexts. Realising how technological interventions can be adjusted to suit diverse educational environments would be essential in creating effective and culturally sensitive writing support platforms.

Additionally, the non-electronic learners' behavioural, cognitive, and affective engagement with the WCF, and their attitudes and perceptions towards the WCF provided in paper-based format were not explored and compared with those of the electronic group. This was due to the fact that a sequential explanatory mixed-methods approach was carried out, in which further qualitative data collection and analysis (in this study, a stimulated recall technique and an individual semi-structured interview) needed to be conducted with the learners who performed better than their counterparts in the quantitative part of the study. This may encourage EFL researchers to explore non-electronic EFL learners' engagement with WCF, check their attitudes and perceptions towards WCF provided non-electronically, and compare them with those of electronic learners to yield more insights into the findings. Furthermore, the current study took one term (i.e. 20 sessions) to explore the impact of AWCF on the EFL learners' academic writing skills, which did not allow for further explorations. Therefore, EFL researchers are recommended to explore the impact of AWCF on EFL learners' academic writing skills for a longer period of time to more profoundly explore different factors involved in developing EFL learners' academic writing skills. Following Costa et al. (2019), the utilisation of technology needs to be explored "in more nuanced and critical ways" to make possibilities for future researchers to explore various dimensions of technologies (p. 396).

Appendix A: Interview questions

1. How did using the online platform for written corrective feedback impact your overall writing experience and language learning journey?

2. Can you describe any specific features or functionalities of the online platform that you found particularly helpful in developing your writing skills and accuracy?
3. In what ways did the feedback and suggestions provided by the online platform contribute to your language development and self-assessment of writing abilities?
4. How did the accessibility and user-friendliness of the online platform influence your motivation and commitment to using it regularly for language practice and development?

Funding Open Access Publishing Support Fund provided by Lingnan University

Data availability The participants of this study did not give written consent for their data to be shared publicly, so due to the sensitive nature of the research supporting data is not available.

Declarations

Ethical approval I confirm that all the research meets ethical guidelines and adheres to the legal requirements of the study country.

Conflict of interest Not applicable.

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