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Analysing Online Peer Editing Behaviours and Their Relationship with Student  
Short-term and Long-term Writing Improvement

THESIS SUMMARY

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Academic supervisor:

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## INFORMATION ABOUT THE APPLICANT AND DISSERTATION RESEARCH

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List of publications of the author of the dissertation, which reflect the main scientific results of the dissertation	<ol style="list-style-type: none"> <li>1. Zhang, H., Southam, A., Fanguy, M., &amp; Costley, J. (2022). Understanding how embedded peer comments affect student quiz scores, academic writing and lecture note-taking accuracy. <i>Interactive Technology and Smart Education</i>, 19(2), 222-235. <a href="http://doi.org/10.1108/ITSE-01-2021-0011">http://doi.org/10.1108/ITSE-01-2021-0011</a></li> <li>2. Zhang, H., Shulgina, G., Fanguy, M., &amp; Costley, J. (2022). Online peer editing: effects of comments and edits on academic writing skills. <i>Heliyon</i>, 8(7), e09822. <a href="http://doi.org/10.1016/j.heliyon.2022.e09822">http://doi.org/10.1016/j.heliyon.2022.e09822</a></li> <li>3. Southam, A., Zhang, H., Cao, R., Fanguy, M., &amp; Costley, J. (2022). How the COI framework explains the online discussion patterns in a flipped course. <i>Innovations in Education and Teaching International</i>, 1-13. <a href="http://doi.org/10.1080/14703297.2022.2130392">http://doi.org/10.1080/14703297.2022.2130392</a></li> <li>4. Costley, J., Zhang, H., Courtney, M., Shulgina, G., Baldwin, M., &amp; Fanguy, M. (2023). Peer editing using shared online documents: the effects of comments and track changes on student L2 academic writing quality. <i>Computer Assisted Language Learning</i>, 1-27. <a href="https://doi.org/10.1080/09588221.2023.2233573">https://doi.org/10.1080/09588221.2023.2233573</a></li> </ol>

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3. *Title: XIII International Conference on Higher Education (ICHE)*

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Title of the presentation: Online peer editing: the influence of comments, tracked changes and perception of participation on students' writing performance

## INTRODUCTION

Peer editing, known as peer feedback, response, or assessment, has long been recognized as a valuable method for enhancing academic writing among students (Cerezo et al., 2016; Chen, 2020; Tseng et al., 2019). Typically, this process involves students giving and receiving written or spoken feedback on each other's work within pairs or small groups (Hansen & Liu, 2005; Kastman-Breuch, 2004). Particularly in second language (L2) learning, peer editing has been recognized as a useful method to improve linguistic and writing skills, such as increasing awareness of the audience, fostering reflective thinking, refining sentence structures and discourse, and enabling collaborative review and application of acquired knowledge (Elabdali, 2021; Hyland & Hyland, 2019; Li, 2018; Villarreal & Gil-Sarratea, 2020; Yim & Warschauer, 2017). Key components of peer editing encompass continuous engagement, shared workload, and the joint creation of a written piece (Ma, 2020), enabling students to receive more feedback and progress at their own pace. Sociocultural theory, grounded in Vygotsky's work, emphasises the co-construction of knowledge when students collaborate toward a common goal, fostering knowledge creation through collaborative dialogue (Moradian et al., 2021; Stahl, 2023). In addition, technological tools like Google Docs have facilitated collaboration and peer editing in education by enabling easy access, encouraging exchanges, and documenting collaborative behaviours (Ishtaiwa & Aburezeq, 2015). Google Docs offers features like embedded comments and track changes, providing students options during online peer editing. Any written type of peer feedback left in the right margin by using "embedded comments" function can be regarded as comments, and the directly changes, including adding and/or deleting words from the original writing content by using "track changes" function can be defined as track changes in the current study. Despite numerous benefits demonstrated in collaborative writing, research on how different online peer editing behaviours enhance writing quality remains nascent.

Existing studies have often focused on how peer editing benefits student writing, mostly from instructors' or researchers' perspectives, neglecting the exploration of the impact of diverse peer editing types in Google Docs on individual writing improvement. There is a lack of comprehensive empirical studies that examine how peer editing behaviour impacts student writing performance in the long and short term in the online context. By investigating the impacts of comments and track changes as two peer editing behaviours mediated by Google Docs on L2 writing performance, our study seeks to close a knowledge gap and add to the expanding body of research in this field.

## STATEMENT OF PROBLEMS

Although some studies have provided helpful explanations for the effects of individual reception and implementation of peer feedback on the quality of writing that students produce as assessed by the course instructor (hereafter referred to as “writing quality” and/or “writing performance”) when writing collaboratively, the majority of the previous studies focused on how peer editing improves student writing from the perspective of the instructor or researcher, or some other general perspectives, such as the semi-structured interview or questionnaires, and there are few studies collect and look at student writing documents and systematically analyse them. Moreover, previous studies regarded all different types of feedback as a whole to explore their impact, but when choosing Google Docs as the platform to conduct online peer editing, there are two methods for students to use to provide feedback, and they may have different influences on student academic writing improvement. Therefore, the impact of comments and track changes on students’ academic writing scores when utilising online collaborative tools is particularly relevant when considering the impact of online peer editing, which calls for better explanation of how diverse online peer editing behaviours affect the quality of student writing.

What is more, when talking about student academic writing performance, previous studies regarded the writing manuscript as a whole and did not separate them into different sections. However, different manuscript sections in a research paper have different characteristics and should be analysed separately. For instance, in the Introduction chapter, topics such as the purpose of the study, the research background, and a technical explanation of the experimental methodology are offered. The Results sections offer the facts and figures of statistical evaluation and experiments. However, additional personal ideas, such as how to interpret the data, what the results mean, and potential paths for future research, should be provided in the Discussion & Conclusion section. Therefore, in different sections, students may provide various types of behaviours and feedback, and it is important to look into how various peer editing behaviours affect various manuscript sections separately.

In addition, previous research on writing in collaboration has primarily concentrated on producing truly collaborative documents that are owned equally by all of the authors (Villarreal & Gil-Sarratea, 2020). However, when one author is the lone owner of a document, as is the case when students ask a classmate to peer edit a document, the results of collaborative acts may vary due to issues with psychological ownership. Students may see their own updates of others’ work as helpful, even when original authors may see student changes as detrimental to the quality of pieces of writing (Mora, 201 et al., 2020). It is difficult to understand the two online peer editing

behaviours (comments and track changes) as separate aspects of learner collaboration because they are frequently explored jointly in the existing research on student collaborative writing. To better understand the effects of each on student academic writing ability, the current study separates the two peer editing behaviours previously discussed through Google Docs.

To sum up, the problem addressed in this study are:

1. Empirical perspective: 1) Previous studies have explored the relationship between peer editing and student writing performance from very broad way, such as questionnaires and interviews, and no research has attempted to look into students writing documents and to record their peer editing behaviours. 2) Most previous research has focused on student writing performance for the final writing document, however, few research have attempted to check the gap between first draft and final draft within the pre- and post- test design.
2. Theoretical perspective: 1) Comments and track changes within the Google Docs platform may influence student writing performance differently, and they need to be investigated respectively. 2) No research has attempted to divide the peer scaffolding into different subtypes to explore how different peer scaffolding affects student writing performance separately.
3. Practical perspective: 1) This study will give teachers or instructional designers, who intend to apply peer editing as the pedagogical method in their class activities, some suggestions about how to conduct this peer interaction to bring the best benefits for student writing improvements.

## **RESEARCH RELEVANCE**

### **Google Docs as an Instrument for Collaborative Writing in Second Language Learning**

Numerous digital educational technologies, including Google Docs, have emerged to foster student engagement and interaction in online learning environments (Lieser et al., 2018). Google Docs, designed for real-time simultaneous writing and editing, serves as a collaborative platform for students to collectively craft and refine content. Its intuitive interface facilitates collaborative writing beyond traditional classrooms, allowing learners to co-create knowledge by discussing, debating, and modifying information (Suwantarathip & Wichadee, 2014). The asynchronous nature of Google Docs encourages reflection, enabling learners to focus more on the writing's substance (Kessler, 2009; Lee, 2010). Its revision history feature provides transparency regarding

alterations made, enhancing accountability among authors (Chuang, 2016). Students can engage with shared documents by adding or deleting text directly using track changes or by providing feedback through embedded comments (Opara et al., 2021). This study utilises Google Docs as the platform for peer editing, focusing on two peer editing behaviours: comments and track changes, with the latter further categorised into word added and word deleted. While computer-supported collaborative learning (CSCL) suggests that student learning is influenced by their technological collaboration, there is a need for deeper exploration into how specific collaborative behaviours during online peer editing impact academic writing performance (Jeong et al., 2019). Prior research indicates that additions to text enhance group learning abilities, while deletions have the opposite effect (Costley et al., 2023). Collaborative writing via Google Docs exposes students to external peer feedback, prompting improvements in their writing. However, a limited body of research has investigated the impact of Google Docs-mediated online peer writing on individual development of L2 learners' writing, despite the reported advantages of collaborative writing using this platform.

### **How comments affect individual writing**

Comments from peers can be seen as a key component in encouraging students to write and thus should be carefully considered when investigating student writing quality (Gan et al., 2021; Nicol et al., 2014). Within the context of this study, 'comments' refer to the dialogic interaction among students using embedded comment functions within Google Docs. Since students are sometimes unwilling to change others' writing directly, embedding comments is an alternative to directly modifying someone else's original text. Students are able to engage in thoughtful criticism of other student writing and make suggestions when they use the comment approach, which typically involves the use of criteria that have been previously set in rubrics (Carless, 2019). Students may participate more actively in the revision process after self-reflection, which might assist them in becoming more autonomous and independent learners and, in turn, more proficient writers (Leijen, 2017).

However, engaging with and interpreting embedded comments can become time-consuming as it involves processing extensive details for each revision in a student's essay (Hyland & Hyland, 2019). This abundance of comments might lead the writer to employ less efficient methods while sifting through them to determine their usefulness (Brookhart, 2017). During the revision process, writers might opt to overlook lengthy comments that have minimal impact on the draft's quality or selectively use recommendations that are easier to implement (Elola & Oskoz, 2016). Due to these concerns regarding comment effectiveness, the current study is conducted with a focus on



peer-to-peer comments and aims to explore the most effective utilisation of comments to aid L2 learners in enhancing their writing proficiency.

In addition, few studies have concentrated on the effect of the number of comments on text revisions and students' writing improvement in the online context, and previous studies have looked at the student essays as a whole, overlooking the impact of comments on the different sections of the essay, respectively. However, different sections of the manuscript have different writing priorities. For instance, the writing in the Introduction, Methodology, and Results sections is more objective (Korstjens & Moser, 2018), and in the Results section, it is more difficult for students to provide comments to improve others' writing, especially when they are not familiar with the specific topic their peers are writing about. In contrast, the Discussion & Conclusion section generally includes more subjective perspectives on data interpretation, conclusions, and future study (Chen et al., 2015), which makes it easier for students to give their opinions to their peers. Thus, the effect of peer editing may vary in different manuscript sections. For this reason, the effects of comments on various manuscript sections should be investigated separately to more fully understand all aspects of peer-to-peer editing.

### **The Influence of Deleting and Adding Words on Student Writing Quality**

Utilising Google Docs during online peer editing involves students inserting and/or removing text in their peers' writing, using the track changes feature. This method has garnered support for its potential to streamline the writing and revision process (Wallace & Hayes, 2020). Since all the revisions and changes are highlighted, using Google Docs might help L2 writers develop awareness of language use in writing as all deleted and added words are shown in a way (an alternative colour) that allows students to quickly check them (Zhang, 2020). This platform also facilitates the identification and rectification of spelling and grammatical errors, potentially enhancing writing quality. However, receiving solely grammatical corrections may lead to doubt in students regarding their peers' reviewing capabilities and may diminish their motivation to write. For example, the mere correction of spelling only highlights mistakes, so it is possible for students to interpret these changes as direct criticism, which could be detrimental to their future writing development (Liu & Edwards, 2018; Storch, 2018). Conversely, a lack of revisions might be interpreted by students as disinterest or lack of engagement, potentially decreasing their writing and task engagement (Li et al., 2015). Moreover, research has highlighted that the addition or removal of content within documents can affect subsequent writing differently.

However, a drawback of the track changes feature is its limited provision of context and information (AbuSeileek, 2013). Students can observe alterations made by their peers without understanding the reasoning behind those changes. Regarding added words, while students might receive examples and suggestions for revisions from peers or instructors during peer editing, these additions may not always align with the original author's intent (Crossley & McNamara, 2016). Consequently, a peer editor could undermine the positive impact of such feedback by altering the author's original ideas, potentially elongating the time spent on considering these adjustments. Specifically, additions were found to be beneficial to writing quality, while deletions were seen as detrimental (Fanguy et al., 2023). Further exploration is necessary to understand the correlation between added and deleted words and writing quality within an online learning environment.

### **The Distinction Between Comments and Track Changes**

Comments and track changes, both employed in online peer editing, exhibit distinct attributes. Embedded comments manifest as suggestions displayed along the right margin of the text, corresponding to the problematic word/sentence, whereas track changes involve highlighting deletions and insertions in a different colour within the original text. In essence, comments offer subtle suggestions in contrast to directly altering others' writing through track changes (Liu & Edwards, 2018). Despite track changes being a noticeable and unique aspect of Google Docs, certain students, especially those unfamiliar with their peers or uncomfortable with the idea of their written text being modified by others, might opt to provide comments rather than directly edit others' writing. For instance, according to Gillis and Krull (2020), students found it awkward to edit others' work due to a perceived crisis of authority. This implies that students may see their own revisions as beneficial, while original authors might view the text changing by their peers as unfavourable. In another study, Ma (2020) discovered that only 3% of students actively revised others' papers, since they may feel uncomfortable and intrusive in changing the content of someone else's writing. Hence, students might lean toward using embedded comments functions over track changes, influenced by a sense of psychological ownership. This psychological ownership might impact the quantity of comments and track changes students receive within shared Google Docs, potentially influencing the subsequent quality of student writing tasks.

### **DEGREE OF DEVELOPMENT OF THE PROBLEM**

Here is the description of how we developed our ideas and improved our experiments step by step.

**Step 1: How peer feedback in general affects student academic writing (paper 1: Understanding how embedded peer comments affect student quiz scores, academic writing and lecture note-taking accuracy)**

Current pedagogical thought suggests that learner-to-learner interaction and collaboration are of great benefit to construct knowledge in a socially dynamic way, particularly for filling potential gaps in existing knowledge (Burden and Kearney, 2017; Retnowati et al., 2018). Online collaborative learning has seen a surge in recent times, and the importance of learner-to-learner interaction and how feedback operates within that interaction has also grown (McNeill, 2011; Meng et al., 2020; Rolf et al., 2014; Zhou, 2017). The study of learner-to-learner feedback as it operates in this social constructivist paradigm is important in the field of online education (Altnay, 2017; Kanala et al., 2013; Yücel and Usluel, 2016). Understanding how learner-to-learner feedback helps students create online learning artefacts, such as collaborative notes on lectures, can be valuable for teachers and designers seeking effective ways to improve student learning, recall and connectedness (Qiu et al., 2012). Because writing has long been considered a valuable and reliable way to access and assess learner understanding and knowledge (Ferretti and Graham, 2019), ways to improve student writing through peer feedback and collaborative notes are relevant in online learning contexts. Existing evidence supports the claim that collaborative learning artefacts can help support student learning (DeChurch and Mesmer-Magnus, 2010). However, how the constituent parts of these learning artefacts interact to support student recall, and retention, and student learning is understudied. Because note-taking has long been understood to assist student recall (Jansen et al., 2017), it is valuable to investigate how peer comments acting as a form of feedback may operate with similar potential benefits.

After reading extensively on collaborative learning and peer feedback, I was curious how collaboration might affect student learning from multiple angles. Thus, we conducted an experiment to explore how learner feedback operates in the form of comments on collaborative notes and how it may affect student performance in the form of quiz scores, their ability to identify key concepts from video lectures (completeness), and their individual academic writing ability overall. This study collected the quantity of student comments during collaborative writing in groups to clarify them as a type of peer feedback that may benefit student learning. However, in that study, students contributed a low average number of comments, limiting the potential benefits of this practice. Therefore, we suggested that teachers should encourage students to provide peer

feedback during collaborative learning to overcome any such inhibition, and they also need to give guidance before students conduct peer feedback. For example, before conducting group cooperative learning, teachers can use examples to show students what good peer feedback is, what types of feedback can improve students' enthusiasm, and how feedback can help them improve their writing skills.

**Step 2: Further categorising peer feedback into different categories (paper 2: Online peer editing: effects of comments and edits on academic writing skills)**

In the second experiment, we applied Google Docs to conduct online peer editing. In order to encourage students to actively participate in the process of online peer editing and provide more comments and edits within the Google Docs, each peer editing session are evaluated to make sure that each person has contributed meaningful changes, suggestions, and/or comments, and each peer editing assignment is worth 1% of students course grade.

After reviewing all the student submissions, I noticed that many students independently made direct changes to others' papers when utilising Google Docs for peer collaboration. This made me think further: Do varied feedback behaviours affect Google Docs students' writing equally? What were the effects if different? Due to the huge class size, I counted the number of comments and edits first and examined their relationship to student writing scores. The second experiment examined how peer comments and edits affect students' academic writing. It measured peer editing by tracking student writing comments and edits in a collaborative learning environment. Data on comments and edits from 5 peer editing sessions with 76 students was collected. The overall individual writing scores accurately reflect students' course performance and learning objectives. This investigation classified online peer feedback as comments or edits and separately examined them in papers to fill a research gap. Our study shows that receiving comments during online peer editing improves student writing. This proves that students may improve their writing by analysing and reflecting on feedback. Interesting results from this study also showed a negative relationship between receiving edits and students' writing performance, which may be due to high edit frequency and insufficient writing skills. These statistics offer two important recommendations for instructors promoting online peer editing: 1) Encourage students to self-reflect after feedback and 2) Before peer editing, suggest ways to make more detailed comments and edits online.

**Step 3: Further dividing edits into words added and words deleted, and separating the whole manuscript into different sections (Paper 3: Peer editing using shared online**

## **documents: the effects of comments and track changes on student L2 academic writing quality)**

I explored “edits” (also named “track changes” later) more after the second experiment to see why edits negatively affect student writing performance. There are two ways for students to choose when editing others’ writing: adding ideas or removing them. However, few researchers have examined how comments, words added, and words deleted, as different types of peer editing, affect student writing. What is the difference between these two methods? Will they affect student writing differently? To answer these questions, the third experiment also applied Google Docs as the platform. In addition, participants in our research watched videos about how to write different sections of a scientific paper. Thus, how will students perform in different manuscript sections? Considering that different manuscript sections have diverse writing styles and qualities, such as Methodology and Results being more objective and Discussion & Conclusion being more subjective, each section should be examined separately. Therefore, in-depth analysis of Google Docs peer editing was used to explore the association between peer editing components and student writing quality for different manuscript sections. The results suggest that the quality of student writing in the Introduction section was favourably connected with editor-deleted words and negatively correlated with editor-added words. Words added positively correlated with student Introduction and Discussion & Conclusion parts. That study found that internet comments have no impact on student academic writing, a result that contradicted prior studies. Although this study had significant limitations, its findings are useful to instructional designers and students. Specifically, without a pretest/posttest design, it was not possible to control for student writing ability before obtaining feedback, which may have affected results.

### **Step 4: Pre- and post-test design to build on the original foundation and investigate how different peer editing behaviours affect student writing scores in both the short-term and long-term**

After the third step, we decided to conduct the experiment more systematically to improve validity and generalizability. The current study involved 239 English language learners enrolled in an academic writing course at a Korean university, organised into pairs to engage in online peer editing. Over a 16-week period, each student completed a writing pre-test, four writing tasks with initial and final drafts, and a writing post-test individually. Four distinct manuscript writing scores were analysed to assess the impact of various peer editing behaviours. More systematic research questions and research methods are shown below.

## **AIM AND OBJECTIVES OF THE STUDY**

The purpose of the current study is to evaluate the impact of students' online peer editing behaviours on the quality of the academic writing that they produce in their second language utilising Google Docs as the research platform. This study used a pre- and post-test design to examine the effects of collaborative writing via Google Docs on the development of L2 individual writing over a 16-week period to achieve its goals. In order to understand the relationships between different online peer editing behaviours (comments and track changes) and student academic writing improvement (i) in the short term (the writing improvement between the initial draft and the final version) and (ii) in the long term (the writing improvement between pre-test and post-test), the current study examined students who participated in peer editing in an online scientific writing class in a Korean university. More specifically, the present study has the following objectives:

1. Investigating the online peer editing that individuals engage in and explore the writing improvement of students.
2. Examining the online peer editing behaviours that individuals engage in to better understand how these behaviours affect the improvement of student writing in the short-term.
3. Examining the online peer editing behaviours that individuals engage in to better understand how these behaviours affect the improvement of student writing in the long-term.
4. Examining Google Docs as one of the software tools that practitioners and academics can use to implement and analyse peer editing.
5. Providing recommendations to practitioners and academics about how to improve online peer editing activities in their own courses.

## **RESEARCH QUESTIONS AND HYPOTHESES**

The existing body of research on student collaborative writing often merges the study of two online peer editing behaviours, comments and track changes, making it challenging to discern their distinct roles in student collaboration. The present study aims to disentangle these two behaviours facilitated by Google Docs to better comprehend their individual impacts on student writing scores. Moreover, as different sections of a manuscript exhibit varying characteristics, investigating them separately may better facilitate comprehensive scoring for students. Four primary research questions with corresponding hypotheses were formulated within this framework:

**Research Question 1 (RQ1):** What extent of improvement did the students achieve in their overall writing performance throughout the study period?

**Hypothesis 1 (H1):** Post-writing assessments will demonstrate higher scores compared to pre-writing evaluations.

**Research Question 2 (RQ2):** How did the students advance in the (a) Introduction, (b) Methodology, (c) Results, and (d) Discussion & Conclusion sections during the study?

**Hypothesis 2 (H2):** Final version scores will surpass initial draft scores across these sections.

**Research Question 3 (RQ3):** What is the relationship between student short-term writing improvements in (a) Introduction, (b) Methodology, and (c) Results, and (d) Discussion sections and peer editing behaviours of (i) deleted words, (ii) added words, and (iii) comments?

**Hypothesis 3a (H3a):** Higher final version scores correlate with increased comments received by students.

**Hypothesis 3b (H3b):** Higher final version scores correlate with increased words added received by students.

**Hypothesis 3c (H3c):** Higher final version scores correlate with increased words deleted received by students.

**Research Question 4 (RQ4):** What is the relationship between student long-term writing improvements in (a) Introduction, (b) Methodology, and (c) Results, and (d) Discussion sections and peer editing behaviours of (i) deleted words, (ii) added words, and (iii) comments?

**Hypothesis 4a (H4a):** Higher post-writing test scores correlate with increased comments received by original authors.

**Hypothesis 4b (H4b):** Higher post-writing test scores correlate with increased words added by peers.

**Hypothesis 4c (H4c):** Higher post-writing test scores correlate with increased words deleted by peers.

Table 1 shows the relationship between research objectives and research questions.

**Table 1**

*The link between research questions and research objectives*

Research Questions	Research Objectives
RQ1	Objective 1, 4
RQ2	Objective 1, 4
RQ3	Objective 1, 2, 5
RQ4	Objective 1, 3, 5

## **THEORETICAL FRAMEWORK OF THE STUDY**

### **Computer-supported collaborative learning theory**

Computer-supported collaborative learning (CSCL) and Vygotsky's sociocultural theory of learning were theoretical frameworks that provided strong support for the growing use of peer editing in L2 academic writing settings over the past 20 years (Jeong et al., 2019). Recent research has shown that making appropriate pedagogical use of CSCL environments can create a natural environment to help students conduct online peer editing naturally while fostering links between information, communication, and argumentation among students and other cognitively challenging tasks that can promote higher-order interactive inquiry processes compared to independent learners (Greenhow & Askari, 2017; Li et al., 2020). Online peer editing is conceptualised as a process that takes place when there is contact between students through the utilisation of technology in CSCL (Cress et al., 2021). CSCL supports both synchronous and asynchronous contributions to a shared learning object, regardless of place or time. Students who review, provide comments, and track changes together to complete peer editing using shared online document platforms, such as Google Docs, can profit not just from cooperation with one another but also from the final written product created by those interactions. However, there is a need to explore how different peer editing behaviour impacts students' writing improvement in both the short and long run.

### **Sociocultural theory**

The significance of social interaction with peers for learning was also emphasised in the zone of proximal development (ZPD) by the sociocultural theory of learning (Vygotsky, 1978), where students develop from their actual levels of writing to prospective writing levels with the assistance



and scaffolding of their peers after receiving comments and/or track changes in the process of online peer editing. In other words, peer editing mediated by shared online documents, such as Google Docs, creates an instructional opportunity that is beneficial for both editors and authors to work within their respective ZPD (Yu & Hu, 2017). According to the collaborative learning paradigm, knowledge is socially constructed through dialogue with other knowledgeable members of a society. Some types of knowledge about writing can be learned through peer collaboration (Zhang, 2020). The collaborative learning paradigm states that conversing with other informed members of a community allows for the social construction of knowledge, and the process of peer cooperation can be used to learn some forms of L2 academic writing skills (Yang, 2016). Also, Rouhi and Vafadar (2014) stated that feedback from web-based peer editing promotes cooperative action, mutual scaffolding, consciousness-raising, and the process of creating social meaning. However, so far, no study has attempted to further categorise student scaffolding to adequately explain the social processes that students engage in when cooperating. The present research attempted to divide the peer editing mediated by Google Docs into different behaviours and to explore how different peer editing behaviours as two different scaffoldings may influence student academic writing performance, that is, how different scaffolding affects student subsequent learning performance.

By combining CSCL and sociocultural theory, online peer editing becomes a collaborative learning environment where students actively engage in knowledge construction through social interactions and the use of digital tools. These two theories interact with each other to support the current study. In detail, sociocultural theory emphasis on ZPD and peer scaffolding is facilitated by CSCL's tools, enabling students to provide targeted support and feedback to their peers during the writing process, and in return, online platforms support sociocultural theory's focus on cultural tools and mediation, allowing students to understand and respect diverse writing practices and perspectives. In conclusion, the integration of CSCL and sociocultural theory in online peer editing not only enhances the effectiveness of feedback and revision processes but also promotes collaborative learning, cultural understanding, and cognitive development among students. These theoretical frameworks provide a robust foundation for understanding why online peer editing is beneficial in fostering both writing skills and broader educational outcomes.

## **METHODOLOGY AND METHODS**

The study involved 239 individuals enrolled in a 16-week graduate-level scientific writing course at a Korean university. The demographic details of these participants are outlined in Table 2. All participants pursued majors in science, technology, engineering, and mathematics (STEM).

**Table 2***The Demographic Variables for the Participants (N = 239)*

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<b>Gender</b>	<b>Male</b>	<b>Female</b>		
	167	72		
<b>Nationality</b>	<b>Korean</b>	<b>Foreign</b>		
	205	34		
<b>Degree</b>	<b>Masters</b>	<b>Ph.D.</b>		
	167	72		
<b>Age</b>	<b>Min</b>	<b>Max</b>	<b>Avg</b>	<b>SD</b>
	22	43	26.69	2.86

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### **Research Design**

Quasi-experimental designs are used when random assignment to treatment and control groups is not feasible. Instead, these designs rely on pre-existing groups while still allowing for the examination of causal relationships between variables. In the present study, course instructors administered a total of 12 sections of the scientific writing course examined in this study. The goal of this online academic writing course was to teach students how to prepare papers for scientific publications. The course was delivered online using pre-recorded videos that were uploaded to students' learning management systems, allowing them to pause, rewind, and fast-forward the information at their own pace. There were 56 lecture films in total for the ten weeks, with four to eight lecture videos per week. The duration of the course videos varied, averaging roughly 12 mins and addressing topics linked to STEM graduate writing. The ten weeks were made up of five two-week sessions with the goal of providing instruction on the four major sections of journal papers: 1) Introduction, 2) Methodology, 3) Results, and 4) Discussion & Conclusion, 5) Abstract. However, the abstract was not included in this study because it did not undergo a peer-editing process like the other sections. Each week, these sections were taught. In the first week of each

two-week session, students watched movies related to their section of interest to learn the aim, function, features, and conventions. After that, students would use Zoom online meeting software to discuss the course with the instructor under university licence. After discussing the video's main points and answering student questions, the instructor split the class into small groups for online discussion to help students understand the lecture videos. In the second week of each two-week session, students watched another set of lecture videos on writing style, vocabulary, and grammar related to the same journal paper section. After this video session, each student was encouraged to structure and lengthen their papers, that is, writing assignments assigned by the instructor, according to their field's journal writing guidelines with no word limit. They had to draft half the manuscript before the second Zoom meeting. These Zoom meetings included brief talks, questions, and peer editing advice from the teacher. Students answered a questionnaire about their field of research, degree program, research experience, and project titles at the first peer editing session. This data was collected in a spreadsheet and given to the class, allowing students to match up with peers with comparable research interests for peer editing. Then, the lecturer placed peer editing dyads (or triads in odd-numbered course sections) into Zoom breakout rooms to collaborate on Google Docs. Peer editing dyads were consistent throughout the semester and were asked to review each of the four sections of the scientific manuscript during each of the four peer editing sessions. The instructor created dyad-specific Google Docs documents to monitor peer editing. Students were instructed to copy and paste their journal manuscript parts into their Google Doc.

For this investigation, a pre- and post-test design was adopted. In particular, students were required to write a Research Proposal for a pre-test that was given during the first week of the course, and an Abstract for the manuscript they had been working on during the course for a post-test that was given during the course's final week. The university department that offered the Scientific Writing course that was the subject of the current study required both the pre- and post-test. The department decided to use the Research Proposal and Abstract assignments for the writing pre- and post-test because these passages are comparable in that they both require one-paragraph summaries of the significance and extent of a specific research project. As a result, a department committee in charge of the graduate Scientific Writing course's instructional standards decided that these tasks were comparable enough to warrant comparison in order to gauge how much the students' writing skills had improved. The course instructor evaluated the Research Proposal and Abstract assignments using virtually identical rubrics because of their high degree of resemblance, which was used for the pre- and post-test, respectively. These rubrics were chosen and required to be used in the course by the department committee.

Students had to write an abstract for the article they had been writing about for the course as part of a writing post-test that they had to complete during the final class meeting in Week 11. Students were required to use a writing exam application on the course learning management system to write for fifteen minutes on their research topic. The exam procedures were the same as those for the pre-test. The exam was proctored by the course instructor, who made sure that students were not using any other software or visiting any other websites while taking the test. Table 3 provides a layout of the activities and assignments for the course.

**Table 3**

*Weekly Learning Content and Activities in the Scientific Writing Course*

Week	Topic	Video #	Note #	Quiz #	In-class activity	Assignment
1	Course Orientation	NA	NA	Pre-test	NA	Select a research topic
2		NA	NA	NA	Writing Pre-test: Research Proposal	NA
3	Introduction	1 – 8	1	1	Group writing activity: Introduction	1st draft of Introduction
4		9 – 13	2	2	Peer editing Introduction	Final draft of Introduction
5	Methodology	14 – 17	3	3	Group writing activity: Methodology	1st draft of Methodology
6		18 – 19	4	4	Peer editing Methodology	Final draft of Methodology
7	Results	20 – 23	5	5	Group writing activity: Results	1st draft of Results
8		24 – 28	6	6	Peer editing Results	Final draft of Results
9	Discussion & Conclusion	29 to 32	7	7	Group writing activity: Discussion & Conclusion	1st draft of Discussion & Conclusion
10		33 – 36	8	8	Peer editing Discussion & Conclusion	Final draft of Discussion & Conclusion
11	Abstract (post-test)	37 – 44	9	9	Group writing activity: Abstract	

12		45 – 50	10	10	Writing Post-test: Abstract Peer editing Abstract	Final draft of Abstract
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All of the scientific writing courses were taught by two instructors. Initially, the instructors needed to create and upload the online videos to the student learning management system for students to access and watch. Furthermore, throughout the Zoom discussion, the instructor had to respond to student questions regarding online videos. In addition, the instructors created and shared all of the Google Docs used by the students during the semester and created and assigned students to various groups for the purpose of conducting online peer editing. The last duty was to evaluate students' writing based on certain criteria for each manuscript section. The process of assigning and determining grades is important due to the existence of two distinct roles (both teacher and teaching assistant) responsible for this task. In the initial step, a concise lesson is conducted to explain the rubric. Following this, in the second step, the teaching assistant scores a few example sections as the practice. Subsequently, in the third step, any discrepancies in the scores assigned by the teaching assistant are thoroughly discussed with the instructor until a consensus is reached, aiming for a closely aligned assessment. This entire process is iteratively repeated for each section, ensuring a consistent and accurate evaluation through collaboration between the teaching assistant and the instructor.

Controlling for the instructors' involvement during online peer editing is challenging. However, the instructors made no comments or changes within the peer editing Google Docs, so any improvements in student writing were regarded as being influenced by peer contributions.

### **Measures**

#### **Comments**

Any written type of feedback that students get from a peer editing partner on their individual writing can be regarded as comments in the present study when students make use of the integrated comment functions inside the Google Docs platform. The number of unique embedded comments and responses to comments within a single peer editing Google Doc act as the *comments* variable. Editors and authors can also utilise embedded comments to engage in online discussions.

### **Words Added**

The words added variable is recorded by calculating the total number of words added to a specific Google Doc by a peer editor during a specific editing session. When students review others' writing, they may add their thoughts to the original author's pieces of writing. Prior research demonstrated that an increase in such changes by peers was positively associated with students' ability to write coherently and support their arguments with evidence (Yim et al., 2017).

### **Words Deleted**

In the present study, the total number of words removed from a specific Google Doc by a peer editor during an editing session can be regarded as the words deleted variable. When students review their peers' writing, in addition to adding their own ideas to the original author's text, they can also directly make deletions.

### **Writing Assignments**

Writing quality in the current study refers to students' ability to produce well-written and well-structured papers, and it is evaluated by the course instructor through the use of scores given using rubrics. The key sections of a research manuscript were the core tasks for the writing course of interest in this study: 1) Introduction, 2) Methodology, 3) Results, and 4) Discussion & Conclusion. The course instructor as well as the teaching assistant graded these writings using a customised rubric modified from Clabough and Clabough (2016). These rubrics were chosen for use in the present study because they showed high scoring reliability and because both instructors and students found them to be useful in the assessment of pieces of writing (Clabough & Clabough, 2016). The rubrics were slightly adapted from their original form, as the original rubrics created by Clabough and Clabough were designed for neuroscience research, whereas the course examined in the present study was geared towards a variety of science and engineering majors. Therefore, wherever necessary, the language of rubrics was made more general in order to better describe research writing from a variety of fields. As an example of this, for the Results section, the Clabough and Clabough rubric was written to describe statistical research, which is common in the field of neuroscience, the present study used an adapted version of this rubric that used more general language to describe a wider variety of research methods. Students were given two days after the second Zoom meeting to think about the comments they received. Based on such comments, they were assigned to finish the final draft on the course learning management system,

where the teacher offered comments, suggestions, modifications, and a final grade. A final instructor-assessed mark out of 10 was provided to each written piece, accounting for 10% of the student’s course grade (with written sections accounting for 50% of the total grade points).

### Data Preparation

There were 60 missing values in the dataset, accounting for approximately 0.31% of the total data points (19,359). Visual inspection suggested that these missing values occurred randomly. To address this, the missing values were imputed using the k-Nearest Neighbour algorithm from the bnstruct R package (specifically, the knn.impute function by Franzin et al., 2017). This imputation method generated a complete dataset that was utilised for further analysis.

### Instruments

In this research, a set of six rubrics were utilised to evaluate student writing skills. The assessment covered General Writing Ability (pre and post; represented as  $\theta_1$  and  $\theta_2$ ) using a four-item rubric focusing on Context, Scope, Value, and Language (refer to Table 1). Additionally, the quality of writing in specific sections, such as Introduction, Methods, Results, and Discussion & Conclusion, were evaluated for both initial and final drafts (represented as  $\theta_{\square 1}, \theta_{\square 2}; \theta_{\square 1}, \theta_{\square 2}; \theta_{\square 1}, \theta_{\square 2}; \theta_{\square 1}, \theta_{\square 2}$ ) using separate four-item rubrics. These rubrics were adapted from Clabough and Clabough (2016), validated in earlier research (Zhang et al., 2022), and demonstrated satisfactory psychometric properties in the current study (see Table 4).

**Table 4**  
*Psychometric Properties for Writing Ability and Chapter Quality Scales*

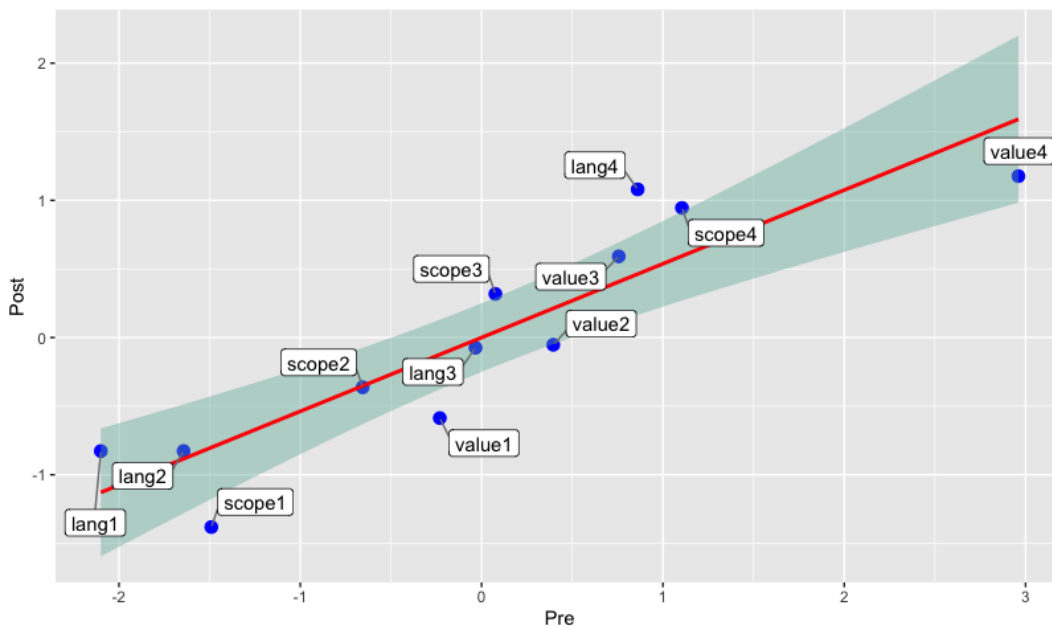
Time	Item focus(Item-rest correlation coefficient)				Alpha	Alpha <sub>cor</sub>
	Item 1	Item 2	Item 3	Item 4		
<b>General Writing Ability<sup>a</sup></b>						
Pre	Context(.29)	Scope(.33)	Value(.17)	Language(.14)	.42	.88
Post	Context(.10)	Scope(.24)	Value(.14)	Language(.03)	.25	.77
<b>Introduction Chapter<sup>b</sup></b>						
Draft	Funnel(.25)	Context(.09)	Purpose(.11)	References(.12)	.27	.79
Final	Funnel(.20)	Context(.21)	Purpose(.21)	References(.15)	.36	.85
<b>Methodology Chapter<sup>b</sup></b>						
Draft	Overview(.15)	Repeatability(.37)	Precision(.32)	Justification(.30)	.48	.90
Final	Overview(.01)	Repeatability(.18)	Precision(.14)	Justification(.01)	.16	.66
<b>Results Chapter<sup>b</sup></b>						

Draft	Clarity(.29)	Interpretation(.37)	Vis. Ref.(.39)	Visuals(.16)	.51	.91
Final	Clarity(.04)	Interpretation(.15)	Vis. Ref.(.05)	Visuals(.11)	.18	.69
<b>Discussion &amp; Conclusion Chapter<sup>b</sup></b>						
Draft	Interpretation(.34)	Comparison(.26)	Structure(.36)	Contribution(.36)	.53	.92
Final	Interpretation(.10)	Comparison(.12)	Structure(.28)	Contribution(.29)	.36	.85
<i>Note.</i> Item-rest correlation represents the item's correlation with the total score of the scale (with the item's contribution from the total score removed, Willse, 2018); the four items for the scale used partial credit scoring <sup>a</sup> 0-4 (max total = 16) and <sup>b</sup> 0-2 (max total = 8); $\text{Alpha}_{\text{cor}}$ = corrected alpha given 40 items (adjustment for Cronbach's alpha's bias against scales with low number of items; Spearman, 1910).						

Both pre- and post-tests for general writing ability shared four common items. To ensure accurate estimation of student writing ability at both time points, a common-item fixed anchor approach was proposed. However, before proceeding, an evaluation was conducted to confirm the similarity in item difficulty across the pre- and post-tests. Two separate calibrations were performed for each test matrix, fixing the average item thresholds at zero (Wu et al., 2016, p. 241). Subsequently, a plot (Figure 1) was generated to visually assess the equivalency of item performance across the different test administrations.

**Figure 1**

*Equivalency of Common Item Thresholds for Assessment of Pre and Post General Writing Ability*



*Note.* Thresholds denote level of ability where students have a .50 probability of achieving the stated item category, e.g., value3 = student ability necessary for .50 probability of achieving category 3 for the value item; standard error of equating = 0.21; regression line in red; 95% confidence intervals in green (see R Core Team, 2022, base stats package predict function).



Upon visual inspection, it was observed that the three link items and their respective categories showed similar functioning in both the pre- and post-test evaluations of general student writing ability. Subsequently, a common-item fixed anchor equating procedure was employed to estimate Pre- and Post-General Writing Ability ( $\theta_1, \square_2$ ) for this study. Rasch modelling, specifically the TAM R package's tam.mml function, aided in conducting this procedure, with the pre-test calibration centred on student ability ( $\theta_1$ ).

Given the complete equivalence of items across rubrics assessing the initial drafts and final versions of each chapter (Introduction, Method, Results, Discussion & Conclusion), no item equating was required. However, to enable comparative scores across both time points, eight separate Rasch partial credit calibrations were performed, with items fixed at zero for each associated assessment.

It is important to note the temporal sequence of assessments: pre general writing ability was assessed first, followed by the drafts and final versions of the Introduction, Methods, Results, and Discussion & Conclusion chapters. Lastly, the final assessment, the Abstract assignment, was conducted at the end of the course during a timed exam, assessing post general writing ability. Online peer editing behaviours were collected based on the quantity of (a) "Deleted" words, (b) "Added" words, and (c) the number of "Comments" from the editor.

### **Data Analysis**

The statistical analysis methods varied for each of the four research questions. To assess the extent of improvement in general writing ability (RQ1), a paired sample t-test (or its non-parametric equivalent) was utilised to determine the statistical significance of the differences. Cohen's d was also planned for evaluating the practical significance of these differences, interpreted as follows: .20 indicating a small effect, .40 representing a moderate effect, and .60 indicating a large effect (Hattie, 2009). The same analytical approach was applied to examine the extent of students' improvements in their respective chapters (from draft to final; RQ2).

For RQ3, which aimed to explore the influence of peer contributions (deleted words, added words, and comments) on chapter improvements, a residualized approach was employed. This method involved regressing students' final chapter quality ( $\theta_{2\square}, \square_{2\square}, \square_{2\square}, \square_{2\square}$ ) on their original draft quality ( $\theta_{1\square}, \square_{1\square}, \square_{1\square}, \square_{1\square}$ ) to measure growth. By controlling for the draft quality, this approach estimated the unique impact of peer contributions (words added, words deleted, and total comments) on chapter writing quality. Path analysis was conducted using the sem function within

the R lavaan package to interpret the standardised regression coefficients and note significance at the  $p < .05$  level. Additionally, the practical significance was assessed using  $f^2$  ( $f^2 = R^2/1 - R^2$ ) for the final versions, where an  $f^2$  of 0.02 represented a small effect, 0.15 a moderate effect, and 0.35 a large effect (Cohen, 1992).

Path analysis is employed to model findings for RQ4, where the ultimate outcome, General Writing Ability ( $\theta_2$ ), is evaluated based on several potential contributing factors, encompassing (a) the initial General Writing Ability ( $\theta_1$ ), (b) the quality of the students' respective post-writing drafts ( $\theta_{21}$ ,  $\square_{2\square}$ ,  $\square_{2\square}$ ,  $\square_{2\square}$ ), and (c) the corresponding collaborative behaviours by peers for each chapter (deleted words, added words, comments). Consequently, a more inclusive residualized approach to gauging progress is implemented, considering both the initial General Writing Ability of students and the quality of their post-writing chapters to explore the possible impact of peer contributions on enhancements in general writing ability.

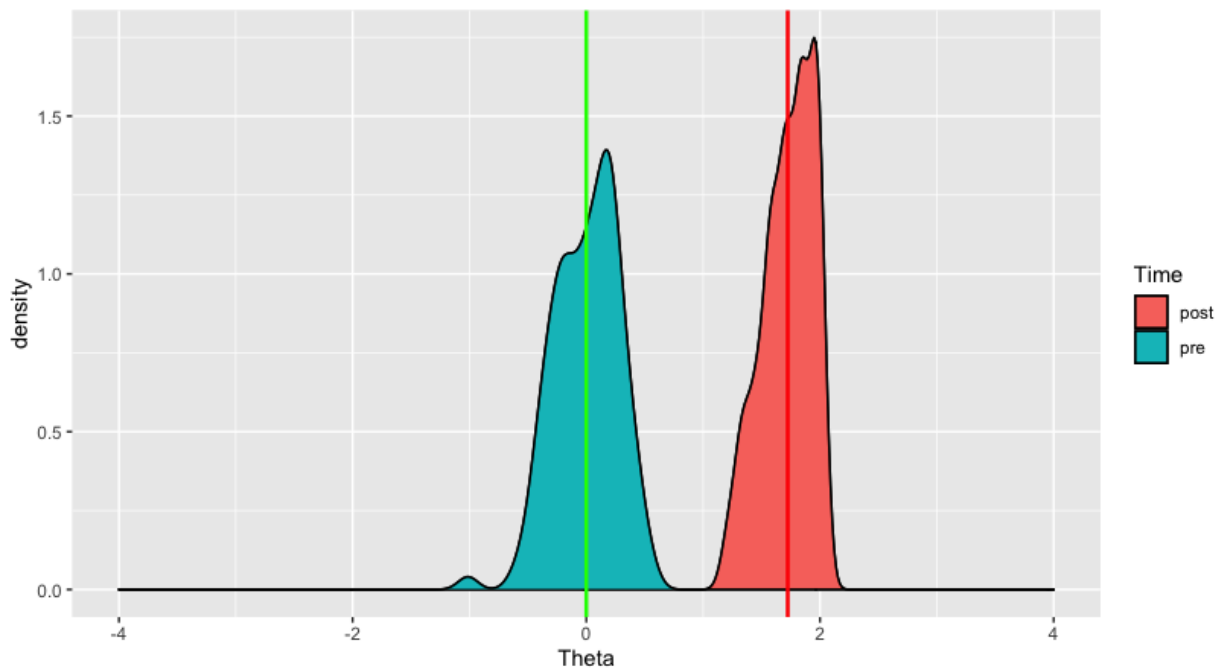
## MAIN RESULTS OF THE STUDY

### **RQ1: What extent of improvement did the students achieve in their overall writing performance throughout the study period?**

According to analysis, students' overall writing skills improved during the course.  $M_1 = 0.00$ ,  $SD_1 = 0.27$  (skewness<sub>1</sub> = -0.48) and  $M_2 = 1.72$ ,  $SD_2 = 0.21$  (skewness<sub>2</sub> = -0.55) were the results of the pre-test and post-test, respectively. Raw scores rose from an average of 9.96/16 (SD = 2.65) to 14.08/16 (SD = 1.68), indicating a significant improvement in the group's overall writing proficiency. A graphic representation of the increase in general writing abilities may be seen in Figure 2.

### **Figure 2**

*Density Plot Comparing of Pre and Post General Writing Ability*



**Note.** Green line is mean ability for Pre-General Writing Ability; red line is average ability for Post General Writing Ability; plot generated with the assistance of R ggplot2 package (Whickham, 2016).

Since the difference in general writing skill ( $\theta_2 - \theta_1$ ) did not follow a normal distribution (Shapiro-Wilk  $W = 0.98, p < .001$ ), a paired samples Wilcoxon signed rank test was conducted on the data. The results indicated that there was a statistically significant change in performance, with a  $V$  value of 0.00,  $p$  value less than .001, and an effect size of 7.01 (which is considered large, exceeding 0.6).

**RQ2: How did the students advance in the (a) Introduction, (b) Methodology, (c) Results, and (d) Discussion & Conclusion sections during the study?**

The results are presented in Table 5. Analysis indicated that students demonstrated progress in all four chapters.

<b>Table 5</b> <i>Pre-Post Comparison of Introduction, Methods, Results, and Discussion &amp; Conclusion Writing Quality</i>												
Pre-Total	$SD_{pre}$	Post-Total	$SD_{post}$	$\theta_{.1}$	$\square\square_{.1}$	$\theta_{.2}$	$\square\square_{.2}$	S-W ( $\square_{.2}-\theta_{.1}$ ) W	$p$	Wilcoxon- Rank V	$p$	$d$
<b>Introduction</b>												
4.17	1.13	6.22	1.22	0.4	0.3	2.0	0.47	0.98	< .001	28,680	<.001	3.82
				5	7	8						
<b>Methods</b>												
4.95	1.76	5.98	1.33	0.6	0.5	1.2	0.15	0.98	< .001	620	<.001	1.61
				2	3	5						

Results												
5.31	1.63	6.22	1.19	0.9	0.6	1.5	0.18	0.96	< .001	1,911	< .00	1.31
				6	2	6					1	
Discussion & Conclusion												
4.94	0.74	6.47	1.32	0.8	0.7	1.7	0.41	0.91	< .001	395	< .00	1.45
				6	4	4					1	
<i>Note.</i> S-W = Shapiro-Wilk assumption test of normality for differences ( $\square_{.2-\theta.1}$ ); Wilcoxon-Rank Paired Test used as assumption of normality not met; $d$ = Cohen's $d$ .												

**RQ3: To what degree do (i) deleted words, (ii) added words, and (iii) comments have on improvements in students' (a) Introduction, (b) Methodology, (c) Results, and (d) Discussion & Conclusion chapters?**

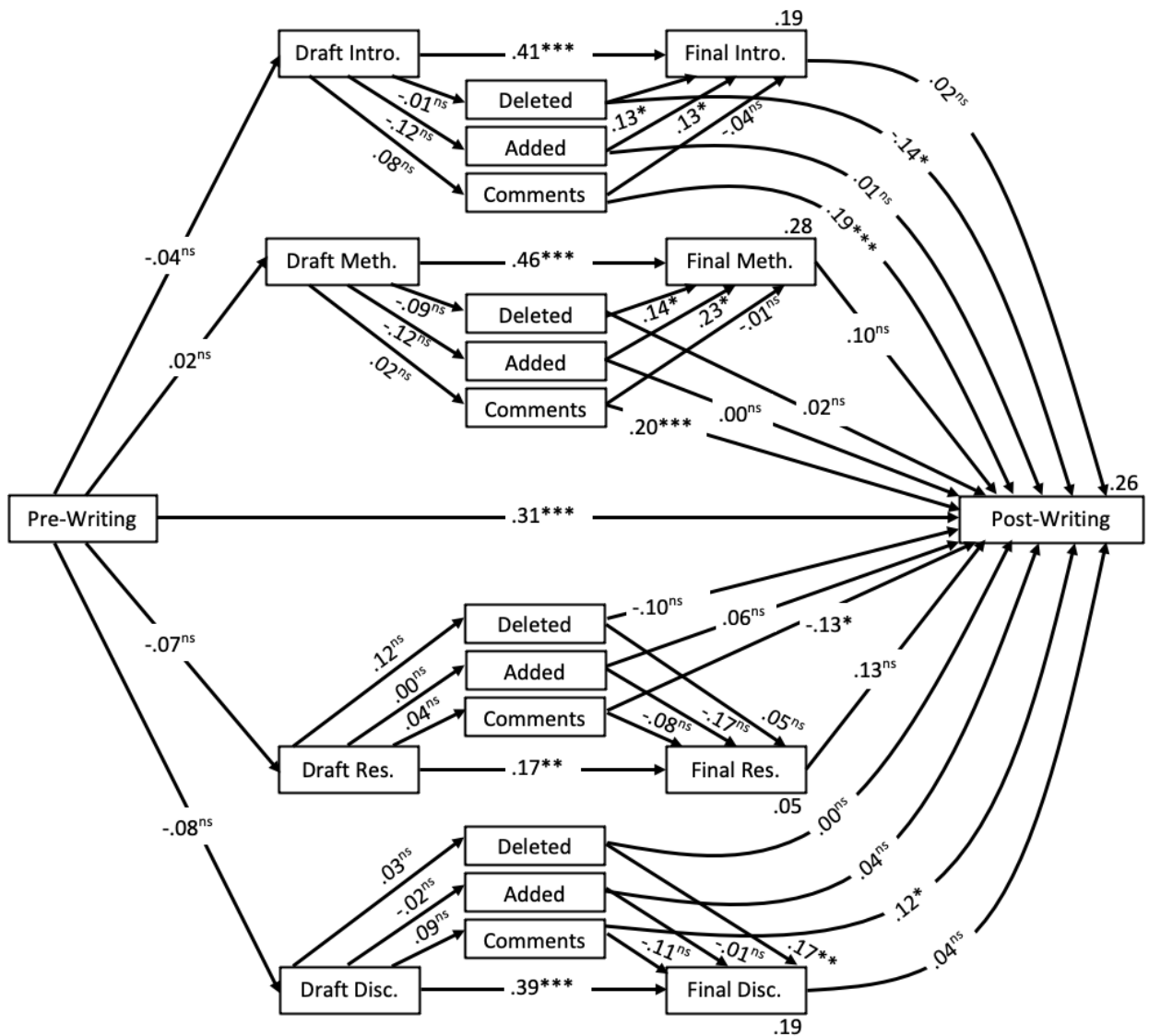
The outcomes for these inquiries are presented in Figure 3. Pay particular attention to the coefficients associated with (a) the term “Deleted”, (b) the term “Added”, and (c) the number of “Comments” in relation to the outcomes: Final Intro, Final Methodology, Final Results, and Final Discussion & Conclusion.

**RQ4: To what extent did improvements in general writing proficiency related to the quality of students' (a) Introduction, (b) Methodology, (c) Results, and (d) Discussion & Conclusion chapters, and the peer contributions of (i) deleted words, (ii) added words, and (iii) comments?**

The outcomes for these inquiries are presented in Figure 3. Take note of all coefficients pertaining to (a) the final versions of the chapters, and (b) the contributions made in pairs (words deleted, words added, comments) for each chapter that affect the ultimate outcome after writing.

**Figure 3**

*Full Path Model for Predictors of Improvement in Chapter Drafts and General Writing Ability*



*Note.* All coefficients are standardized;  $R^2$  values in top-right corner of endogenous variable; Final Intro  $f^2 = 0.23$  (large), Final Methodology  $f^2 = 0.39$  (large), Final Results  $f^2 = 0.05$  (small), Final Discussion & Conclusion  $f^2 = 0.23$  (small); \* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$ .

In summary, after checking students grades on final drafts, the findings from the study indicate that comments do not have an impact on students' writing improvement in the short run. However, the adding words and the deleting words were linked to enhanced writing scores specifically in the Introduction and Methodology sections. Furthermore, the words deleted were linked to enhanced writing scores in the Discussion & Conclusion chapter. The results of the analysis on post writing indicated that comments were linked to enhanced writing scores in the Introduction, Methodology, and Discussion & Conclusion sections. However, there was a statistically significant negative correlation between the number of comments and post writing scores in the Results section. Additionally, there was no discernible connection between the number of words added or deleted

and student post writing scores in the Methodology, Results, and Discussion & Conclusion sections. Nevertheless, the removal of words had a positive impact on the post writing scores of students in the Introduction part. Furthermore, there was a positive correlation between comments and student writing scores in the Introduction, Methodology, and Discussion & Conclusion sections, but there was a negative correlation between comments and student writing scores in the Results section.

## **DISCUSSION**

The current study investigated the impact of various online peer editing behaviours on the writing improvement of students. A pre- and post-test approach was applied to examine the impact of comments and track changes on student writing. Specifically, the study examined the relationship between the number of comments and track changes and the extent of improvement in student writing. More precisely, the gap of scores from the initial draft to the final version can be regarded as a short-term improvement, whilst the advancement from the pre-test to the post-test writing can be considered as a long-term improvement. The findings indicate that both peer editing behaviours, specifically comments and track changes, are linked to enhanced student writing. More precisely, an increase in the number of comments has a favourable impact on long-term student writing improvement, whereas an increase in the number of track changes results in short-term improvement in student writing.

The current research demonstrates a statistically significant positive correlation between comments and long-term improvement in student writing across many sections of academic manuscripts, with the exception of the Results chapter. Conversely, comments have a negative correlation with student post-writing scores in the Results chapter. The results indicate that more comments provided to students during the online peer editing process led to higher scores in the Introduction, Methodology, and Discussion & Conclusion sections of their post-writing. This finding aligns with previous studies on collaborative writing and online peer editing, which have demonstrated that comments are beneficial and stimulating in assisting participants to enhance their performance in delayed writing assignments administered a few days after the first work (Dzekoe, 2017). The impact of the quantity of comments on writing quality aligns with previous studies that have shown comments to be a crucial factor in motivating students to write. Comments provide students with increased awareness of their audience by prompting them to reflect on suggestions and opinions from their peers (Nicol et al., 2014). While students may not incorporate all comments in their final drafts, they strive to avoid repeating the same errors in future writing (Koltovskaia, 2020).

The notable improvement in students' writing proficiency can be attributed to the fact that, despite the varying quality of comments, the act of providing and getting constructive feedback for individual assignments heightened the students' awareness of their writing problems or errors. Yalch et al. (2019) argued that students' writing skills increase when they repeatedly examine rubrics while writing their own papers and providing feedback on their peers' work. This is because they develop a deeper knowledge of the standards. Additionally, it is possible that the enhancements were achieved due to the quantity and timeliness of the peer feedback (Ortega, 2017). In this study, participants were provided with comments and instructed to amend them within a week, which may influence the effectiveness of comments. These findings indicate that collaborative group work is advantageous when learners cooperate to create high-quality writing. Additionally, offering more critical comments or recommendations can be advantageous in enhancing students' writing skills over time.

However, the current study demonstrates a negative correlation between comments and long-term progress in student writing, namely in the Results chapter. The findings challenge previous research that suggested comments are the crucial element by which students might derive advantages from peer editing (Tan & Chen, 2022). This could be attributed to the requirement for the Results section to present information in an objective and academic manner, without any attempt to interpret or analyse the data (Myers & Avison, 2002). Consequently, students find it challenging to provide substantial comments during the collaboration, limiting their input to superficial comments regarding spelling or grammatical errors. However, there is evidence suggesting that students may excessively interpret specific cues in unfavourable conditions, leading to exaggerated interpretations and adversely affecting their writing abilities (Elabdali, 2021).

Prior studies have shown that comments from peers can enhance a writer's immediate writing skills and provide motivation for learners (Allen & Mills, 2016; Rahimi, 2013). However, this study goes a step further by establishing that the number of comments received by students is only significantly correlated with long-term writing improvement. In contrast, the quantity of comments provided by editors has no impact on the final version of the student's writing when compared to short-term improvement. The findings of the current study contradict the results of prior studies, which indicated that students get higher writing scores in the final version after obtaining feedback from their peers (Zhang et al., 2022; Baker, 2016). Furthermore, the absence of a correlation between comments and the improvement of students' writing in the short term contradicts certain research findings on collaborative writing. These findings indicate that comments serve as a

valuable tool in helping group participants enhance their writing skills in both immediate and delayed writing tasks (Tang & Liu, 2018).

Furthermore, the original writer may potentially utilise fewer efficient tactics in deciding which suggestions to incorporate when sifting through a substantial volume of comments, and students have the option to disregard long suggestions or selectively adopt only the most feasible advice during self-reflection. Consequently, comments may have little influence on short-term progress. It is important to note that identifying issues in comments does not equate to providing resolutions. Despite being told of the issues in their writings, students may still lack the knowledge on how to enhance the material. Therefore, the influence of comments on improving students' writing in the short term may be diminished.

There was no association identified between the number of track changes and long-term progress in student writing. However, there was a positive correlation between the number of track changes and short-term improvement in writing. To be more precise, students who received a greater number of track changes during online peer editing demonstrated improved performance in the final version of their work, but did not exhibit superior performance in the post writing assessments. The impact of the quantity of track changes on the quality of students' final writing assignments with previous studies that discovered that highlighting changes in online platforms might capture students' attention and subsequently result in improved reflection during peer editing (Yang, 2016). Track changes offer students a variety of suggestions, including correcting spelling and syntactical problems, as well as making revisions at the sentence or paragraph level that focus on the content and structure of a specific piece of work (Chen & Zhang, 2019; Dzekoe, 2017). Thus, making superficial corrections can promptly enhance the quality, content, and organisation of a sentence. This aligns with previous research indicating that students' modifications during online peer editing serve as linguistic support for identifying and rectifying errors at the word and sentence levels. Additionally, these modifications offer suggestions for improving the organisation and substance of the text, resulting in the revision, enhancement, and refinement of the previously presented content and organisation (Hsu & Lo, 2018).

Nevertheless, the existing data suggests that track changes did not have any impact on the quality of student second draft of the Results chapter, when examining the effects of track changes on short-term writing improvement. The findings we obtained appear to contradict several previous studies that utilised online venues for peer editing. Research indicates that students can engage in active studying by analysing their work and seeking to remedy errors, as well as double-checking their own knowledge. This approach can contribute to students becoming more proactive



learners (Zhan, 2022). One factor contributing to this discovery is the difficulty students face in incorporating their own ideas into the writing and removing the original author's concepts in this chapter, especially when they are not familiar with the data collecting and analysis procedures.

Regarding the influence of track changes on long-term improvement in student writing, the results contradict previous studies that showed that editing and revising other people's work not only improves reviewers' ability to identify and correct errors, but also increases the authors' focus on improving their own writing in the future (Lee, 2010). This could have led to enhanced precision in the subsequent L2 writing assignments (Hsu & Lo, 2018). One possible explanation is that while making grammar or spelling modifications may help students identify their writing weaknesses, the overall quality of their writing will ultimately be determined by their long-term writing habits and language skills. Furthermore, when students make changes to a collaborative document on Google Docs, the specific platform used in this study, a significant number of tracked changes can hinder students from individually reflecting on each change. As a result, they may opt to accept or reject all changes simultaneously, which could discourage further involvement in the writing process (Birnholtz & Ibara, 2012).

## **SCIENTIFIC AND PRACTICAL SIGNIFICANCE OF THE WORK**

The present work is an initial step in understanding how online peer editing behaviours on L2 compositions relate to student academic writing quality. When students continually edited their work and offered comments and/or track changes to others, both editors and authors displayed deeper thinking about both the texts written by others and their own writing during the process of online peer editing. This leads us to the conclusion that, in the long run, Google Docs or other similar platforms may be able to assist a larger group of students in developing their writing strategies and abilities. *The results of this study have ramifications for both educational research and practice.* The findings imply that the effects of comments and track changes during online peer editing are comparable in terms of individual writing quality. However, the utilisation of technology-based feedback techniques like asynchronous peer engagement, synchronous online peer editing, and others might not always result in positive outcomes. To help students produce their best work, educators should be aware of the different peer editing behaviours that have the greatest influence on students' writing quality (Panadero et al., 2016). Furthermore, teachers should be encouraged to use Google Docs to set up peer editing exercises in their classrooms because this platform has been shown to be sufficient for facilitating the process of mutual feedback.

*In addition, the results reveal two important implications concerning the use of online peer editing as an instructional method: one pertains to the impact of the quantity of track changes on student immediate writing enhancement, while the other pertains to the effect of the number of comments on students' long-term writing improvement. An initial suggestion is to promote the use of track modifications as a means to help students effectively manage their own learning and enhance the quality of their short-term writing, enabling them to achieve higher grades on their final drafts. An additional suggestion is to promote the use of embedded comments during online peer editing to assist students in generating superior academic writing in the future. To be more precise, instructional designers must establish collaborative writing environments to facilitate the monitoring of peer editing and enable instructors to promote consistent and ongoing participation from each student throughout online peer editing.*

## **THESIS DEFENCE**

The dissertation explores the relationship between different peer editing behaviours mediated by Google Docs (comments and track changes) and student writing performance in both the short term and long term. In order to accomplish the objective, the present study employed pre- and post-testing over a 16-week period to examine the influence of Google Docs-mediated collaborative writing on the progression of L2 individual writing. Consequently, the study focused on students engaging in peer editing within an online scientific writing class to discern connections between online peer editing behaviours (comments and track changes) and the writing improvement of students in both short-term (between initial and final drafts) and long-term (between pre-test and post-test) scenarios. First, the study helps to understand which types of peer editing behaviour may bring more benefits to student academic writing in different time periods. Second, this study offers both theoretical and pedagogical implications for instructional designers and teachers about how to better conduct online peer editing in the future to maximise the benefits of this teaching activity.

The results of the thesis can be summarised in the following statements:

- This study is a first step in understanding how online peer editing behaviours on L2 compositions relate to student academic writing quality. When students continually edited their work and offered comments and/ or track changes to others, both editors and authors displayed deeper thinking about both the texts written by others and their own writing during the process of online peer editing. This leads us to the conclusion that, in the long run, Google

Docs or other similar platforms may be able to assist a larger group of students in developing their writing strategies and abilities.

- There is a statistically significant positive correlation between the number of comments and student long-term writing performance. Additionally, track changes have a positive impact on the quality of student short-term writing. It is important to recognize how various behaviours in online peer editing can accurately predict the quality of student writing performance, including final version scores and post-test writing scores.
- The utilisation of technology-based feedback techniques like asynchronous peer engagement, synchronous online peer editing, and others might not always result in positive outcomes. For example, there was a statistically significant negative correlation between the number of comments and post writing scores in the Results section.
- Results chapter is the most unique chapter in the whole manuscript, because the track changes and comments were linked to enhanced writing scores specifically in the Introduction and Methodology, and Discussion & Conclusion sections except for Results chapter. This may be due to the characteristics of the Results section. Students only need to show their findings without any personal interpretation in the Results chapter, so generally speaking, this chapter is more objective compared to other sections such as Introduction or Discussion. As a result, it is hard for students to offer feedback in this section, especially when they are not familiar with their peers' topics.

## CONCLUSION

Sophisticated online platforms for collaboration and communication, such as Google Docs used in this study, have facilitated a deeper exploration of online peer editing. However, there has not been a comprehensive examination or conceptualization of the diverse behaviours involved in online peer editing. The educational advantages and influence of online peer editing on individual L2 academic writing performance are still mostly unexplored. The current study represents one of the initial efforts to establish a comprehensive connection between the extent of online peer editing behaviours (comments and track changes) mediated by Google Docs and the improvement in the quality of student L2 academic writing.

**As for the limitation,** the complexity and difficulty of monitoring and evaluating student collaboration and interactions during online peer editing should be emphasised, notwithstanding the theoretical and pedagogical insights provided by the current study. Further investigation is

necessary in these domains due to potential associations between peer editing conduct and the enhancement of academic writing, which may vary based on the student cultural backgrounds and the contributions of different students in the same group. The fact that the current research did not particularly examine how students responded to the comments and track changes they received during the online peer editing is another disadvantage of the study. More studies on the effects of peer feedback should be planned in order to investigate the relationship between the use of feedback and the growth of student writing. Although pre-tests and post-tests were administered to all participants to measure their writing abilities at the beginning and end of the study period, and by comparing these scores, I were able to assess the natural progression of writing skills over time, separate from any instructional interventions, students were still affected by some other factors such as the prior writing experience, initial proficiency levels, and the amount of time spent on writing tasks outside of the study activities. In the future, more research should be done to control all other factors and things which could have impacted their writing performance. An additional limitation of the present study is that subjects were allowed to self-select into groups rather than groups being randomly assigned. It is possible that more capable or knowledgeable students may have clustered in groups or, conversely, that lower-level students might have chosen to work together. Therefore, future research could account for this by randomly assigning students to groups to prevent this type of distribution. Besides, in the peer editing process in the current study, I categorise feedback into words deleted, words added, and comments. However, there are some other situations when suggestions or opinions contain the modifying existing text rather than simply adding or removing content. These modifications, which involve altering phrases or sentences to improve clarity, accuracy, or style, etc., need to be defined as “revisions” in the future.

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