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

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Abstract

While peer-editing is considered an important part of developing students' academic writing, questions remain about how different types of peer-editing affect subsequent student performance. The present study looked at a group of university students (N = 149) engaged in peer editing of one another's essays in an online security studies course. The analysis was conducted from two perspectives: feedback givers and feedback receivers. More specifically, the relationships between the giving of comments and tracking changes in peer's work and writing score on essays were explored. The results showed that there was a positive correlation between the total number of received comments and the student's writing score, whereas there was no correlation for the number of tracked changes (neither words deleted, nor words added). Surprisingly, students who assume that peers provide high quality tracked changes demonstrate worse writing performance. This research shows the importance of nuance in understanding peer editing types and their influence on students' performance, as well as highlighting potential complexities of the interplay between students' collaborative activities, their performance, and their attitudes.

Keywords: Comments, Peer editing, Peer feedback, Perception, Tracked changes, Writing performance

Introduction

Peer feedback has been used in classrooms for decades, especially in the context of higher education (Huisman et al., 2018). The spread of collaborative learning (Nokes-Malach et al., 2015), and active learning (Hartikainen et al., 2019), together with the excessive workload on teachers makes peer-to-peer interactions an important alternative source of feedback for learners (Ebadi & Rahimi, 2017). Furthermore, increasing applications of e-learning have led to the spread of technology assisted peer feedback as an alternative to face-to-face interactions (Al-Samarraie & Saeed, 2018; Cheng et al., 2015). The subsequent COVID-19 pandemic has further reinforced this trend of online learning in general and computer supported collaborative learning

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more specifically (Kuyyogsuy, 2022). Peer editing is a form of peer feedback which involves peers providing written or oral feedback to one another on written assignments (van Heerden & Bharuthram, 2021). In academic literature it may also be called peer response, peer review or peer assessment (Hu, 2019).

Peer editing as a type of collaborative activity may be beneficial for many reasons (Nicol et al., 2014; Patchan & Schunn, 2015; Rahimi & Fathi, 2021; Van Popta et al., 2017; Wu & Schunn, 2021). Participation helps students to improve their domain-specific skills (van Zundertet al., 2010), develop high-level thinking and metacognitive knowledge (Zhan et al., 2023), and stimulate knowledge acquisition (Tan & Chen, 2022). Furthermore, interaction with peers stimulates engagement in the learning process and the development of self-assessment skills (Liu & Carless, 2006), as well as providing students with more individual comments (Bijami et al., 2013).

Many user-friendly online applications allow students to collaborate on a variety of tasks, for example wikis, Microsoft (MS) Word, and Google Docs (Biasutti, 2017; Larsen-Ledet et al., 2020; Li & Mak, 2022; Rahimi & Fathi, 2021). Recently, Google Docs has become a popular and widespread instrument for organisation of student writing collaboration (Ali, 2021; Sudrajat & Purnawarman, 2019). It allows students to offer suggestions and opinions by providing embedded comments and/or making direct changes to the text, such as adding or deleting words from a student's original writing (Woodrich & Fan, 2017).

During revision students may learn how to critically analyse the text from the reader's perspective, to identify problems and to figure out successful and unsuccessful writing strategies (Patchan & Schunn, 2015). Furthermore, students can develop different skills both in giving peer feedback and in receiving and then reflecting on it. Based on this experience students may improve the quality of their own pieces of writing (McConlogue, 2015; Nicol et al., 2014). Different types of peer editing mediated by Google Docs may have various impacts on student academic writing performance (Zhang et al., 2022; Blau & Caspi, 2009; Zheng et al., 2015).

However, previous research has examined the role of peer editing from a general perspective and has not divided peer editing into different types (e.g. Huisman et al., 2018; Wu & Schunn, 2021). Also, few attempts have been made to experimentally investigate how the types of peer editing affect students' writing performance by examining students' documents (Zhang et al., 2022; Woo et al., 2013; Zheng et al., 2015). Therefore, more research is needed on how comments and tracked changes link to writing quality in the online context.

Also, the perception of participation in peer editing in general may affect the subsequent analysis of received feedback and willingness to implement it or make some other changes in the text. The minimal amount of peer editing types may be seen as a sign of disinterest by the author, whereas receiving a lot of changes and ideas makes their analysis less and less attractive for the author (Birnholtz et al., 2013). Also, if received peer feedback provides an impression that the peer editor is incompetent, it may cause the feeling of unfairness of the procedure in general or uselessness of received comments (Kaufman & Schunn, 2011). Finally, the perception of comments and tracked changes may vary.

Literature review

For the current study, comments are defined as written feedback on a particular piece of text, which is arranged in a column in the space to the right of the document. This type of feedback within peer editing does not involve direct changes to the original text, whereas tracked changes are a type of written feedback that is captured by directly changing the author's text by adding or deleting words. Comments and tracked changes as two types of peer editing mentioned above are standard and are also available in other applications that have a function for the mutual editing of text, e.g. MS Word (Liu & Sadler, 2003). In addition, they are used for different purposes. Moreover, comments can include identifying strengths, or weaknesses of the text and some ideas for its improvement, whereas minor changes, corrections of grammar or spelling mistakes, etc. are usually suggested in the form of "tracked changes" (Zhang et al., 2022; Ebadi & Rahimi, 2017). For this paper, the term "peer feedback" will be used to review and analyse existing research on the potential benefits and limitations of this type of feedback in general, including in different contexts. While peer editing includes the process of commenting on and directly editing another student's text as main activity types. Therefore, this concept will be used to describe this particular activity and the specific types of peer editing (comments and tracked changes) that comprise it.

How receiving comments and tracked changes may impact writing performance

Receiving comments allows students to see their writing from the reader's perspective, find shortcomings, unclear arguments, or illogical order of ideas, and make necessary changes (Nicol et al., 2014). Also, during the reflection on received comments students learn how to evaluate comments and decline insignificant suggestions (Wu & Schunn, 2021), as well as improve their problem-solving skills for highlighted problems (Nicol et al., 2014). Finally, the analysis of received comments may help students to identify and correct mistakes before the final assessment and close the gap between actual and desired performance (Simonsmeier et al., 2020).

However, receiving comments does not necessarily result in development of student writing performance. For instance, several studies have shown that comments that provide summaries, explanations, or suggestions with evidence are more beneficial to students' writing than those that offer direct praise or criticism (Wu & Schunn, 2021). The potential benefits of received comments are sometimes diminished since students become less motivated when they get feedback without any justification (Nicol et al., 2014). Additionally, if students do not thoroughly evaluate, arrange, or apply their comments throughout the reflecting phase, the effectiveness of the comments will be difficult to judge (Nordrum et al., 2013).

While detailed feedback is usually provided with comments, the edit function is mostly used for direct changes (Chen et al., 2018). In the online environment students tend to directly edit texts in terms of vocabulary and grammar which is often easier than giving feedback about content or structure (Zheng et al., 2015). The "track changes" mode allows the editor to automatically cross out deleted words and mark added ones in a different colour. So, this instrument may attract the author's attention to detected errors and stimulate the cognitive comparison between the original text and reformulated

variant, which makes it different from comment format and potentially even more effective from the perspective of grammar and writing quality (AbuSeileek & Abualsha'r, 2014). The further analysis of suggested changes may help students to improve their writing performance and to avoid the same mistakes in the future (Petrović et al., 2017).

However, there is some evidence that receiving tracked changes may result in lower writing performance in some contexts (Zhang et al., 2022). This may be caused by students perceiving comments from a peer as a source for further improvement, whereas edits they receive may be seen as a deterioration of the text (Blau & Caspi, 2009). Furthermore, according to Birnholtz et al. (2013), the growing number of received tracked changes may reduce the attractiveness of their subsequent analysis and additional rewriting of the text for the author. The nature of tracked changes is also important. For example, primarily grammatical edits may be perceived as a sign of disinterest and demonstrate low level of peer's contribution to the collaborative activity, which may be disappointing for the author of the text (Birnholtz & Ibara, 2012).

Identifying and rectifying spelling or grammar errors could contribute to improving writing quality. However, receiving only grammatical changes might lead students to question their peers' reviewing abilities, potentially reducing their motivation to write (Ruegg, 2018). Although some other superficial changes, such as correcting spelling, may emphasise mistakes, students could perceive these corrections as direct criticism, negatively impacting their future writing development (Kang & Han, 2015). Conversely, the lack of tracked changes might be interpreted by students as disengagement or indifference, which could also detrimentally affect their writing and task engagement (Costley et al., 2023). Furthermore, some studies have highlighted that additive or subtractive changes have different impacts on subsequent writing quality. Specifically, additions were found to be beneficial, while deletions were stated harmful to student writing quality (McCarthy et al., 2022). Further investigation is necessary to better understand how the words added or words deleted relates to writing quality in an online learning environment.

How providing comments and tracked changes may impact writing performance

Some research suggests that giving feedback is more beneficial for a student's writing performance than receiving it (Cho & MacArthur, 2011; Li et al., 2010; McConlogue, 2015), whereas others evaluate both activities as equally effective for further text improvement (Huisman et al., 2018; Wu & Schunn, 2021).

Providing comments, students should apply problem-detection skills for identification of improvement areas and generation of ideas and suggestions, applying criteria and making judgements about the quality of writing—both their peers and their own (Huisman et al., 2017; Nicol et al., 2014). Comparison of texts and taking different perspectives stimulates the development of metacognitive skills and helps to figure out main effective and ineffective writing strategies in texts of different quality level (Patchan & Schunn, 2015; Van Popta et al., 2017; Wu & Schunn, 2021). Through providing comments, students should explain to their peers some ideas and highlight possible shortcomings, articulating their own understanding and developing subject knowledge (Cho & MacArthur, 2011; Van Popta et al., 2017). Finally, through this process, students start

to reflect on their writing and gain some critical insights, which may lead to further improvement of their texts (van Popta et al., 2017).

Also, previous research has revealed that providing tracked changes stimulates students to spot different types of errors in any text—peer's or his own—and structure text more coherently (Wang, 2015), which helps to develop their own writing skills (Yen et al., 2015). Participation in collaborative writing activities as a peer editor involves students in critical reading and makes them check presented arguments and doubtful grammar constructions, which helps to gain more confidence in their language skills (Diab, 2010). Moreover, the "track changes" function facilitates the editing process and allows peer editors to identify and analyse detected mistakes, which leads to significant writing improvement of students who provided this type of peer editing (AbuSeileek & Abualsha'r, 2014; Ebadi & Rahimi, 2017).

How students perception of participation in peer editing may affect writing performance

Perception of participation in peer editing may influence the subsequent analysis of received feedback and willingness to implement it or make some other changes in the text, which, in turn, may offset the benefits of this collaborative activity and negate potential performance improvement. For example, students' learning experience may be affected by the volume of received feedback. Dozens of received comments and tracked changes may upset the author and discourage him or her to analyse the received edits and improve the text. On the contrary, a few pieces of feedback may be interpreted as a sign of disinterest (Birnholtz et al., 2013). Also, the perception of participation in peer editing may be affected by the perceived level of peer editor's competence. Students tend to underestimate the usefulness of received feedback and note the unfairness of the procedure in general if they doubt their peers' level of competence (Kaufman & Schunn, 2011). Finally, the perception of different peer editing types may vary. For example, comments may be perceived as a source for further improvement because they often include detailed information, while tracked changes may be seen as a threat and may decline the quality of writing (Blau & Caspi, 2009). Aforementioned reasons may prevent students from analysing peer feedback and developing writing skills which may neglect benefits from participation in peer editing and negate potential performance improvement.

Present study

Previous research explored the role of peer editing from a general perspective and did not divide peer editing into different types. The current research aims to separate the feedback into comments and tracked changes to explore the impact of providing and receiving peer feedback (in form of comments and tracked changes) and students' perception of participation in peer editing on writing performance. As highlighted in the literature review, each type of peer editing has distinct attributes that draw attention to different facets of the original writing text. Here are several reasons why the focus was only on the quantity rather than the quality of peer feedback: Firstly, examining the correlation between various types of peer editing volume and writing performance can guide the necessity to explore peer editing types or quality.

To do so, the data on a peer editing session of 147 bachelor students were gathered and analysed. Unlike previous peer editing studies that either concentrate on general opinion

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on participation in aspects of this collaborative activity with the help of interviews or focus only on the analysis of peer feedback itself in general (but without its categorization by type), the present study combines both approaches by looking at the relationships between editing types and performance, as well as the perceptions of participation in the peer-editing process. It relies not only on digital footprint data regarding the feedback received, but also on sociological data collected through questionnaires. It seeks to explore the impact of comments, tracked changes and students' perception on writing performance, which were measured through individual writing essay scores. The perception of participation in peer editing was measured with the help of a questionnaire.

Five major research questions are addressed:

(1) RQ1. Is receiving more comments associated with better students' writing performance?
(2) RQ2. Is receiving more tracked changes associated with better students' writing performance?
(3) RQ3. Is providing more comments associated with better students' writing performance?
(4) RQ4. Is providing more tracked changes associated with better students' writing performance?
(5) RQ5. How does the perception of participation in peer editing affect students' writing performance?

Methods

Participants

In total 215 students majoring in security studies were invited to participate in the experiment. However, 62 students did not fill the survey, four more people did not agree to share the data of their survey with researchers. We gathered data of 149 students for further analysis. Then data were checked for outliers with the help of Mahalanobis Distance, Cook's Distance and Centred Leverage Value. The observation was recognized as an outlier when 2 out of 3 mentioned variables were higher than the recommended value. As a result, 2 observations were identified as outliers and deleted from further analysis. So, there were 147 students in the final version of the dataset. There were 66 males and 81 females. The average age of students was 19.36 (SD = 0.7). The minimum and maximum age of participants were 18 and 23 correspondingly. Also, 126 students were Russian, whereas 21 students were identified as international. The average GPA of participants of present study was 6.98 out of 10 (SD = 1.01) with minimum 4.7 and maximum 9.1.

Learning context

There were 215 bachelor students engaged in a security studies course at a large research university in Russia. The discipline is dedicated to competitive intelligence and protection of business from economic and financial risks. The purpose of the course was to teach students how to analyse the business environment, monitor the information about potential counterparties, identify and minimise financial risks.

The discipline was organised in an online format in Microsoft Teams and consisted of 38 classes during one semester. There were different formats: lectures, seminars, and workshops delivered by invited experts, and one business game. The final score for the discipline consisted of scores for an essay, participation in seminars, business game, homework, and a final exam.

A scheme of the procedure of the online peer editing and activities is given in Fig. 1. The list of essay topics is compiled each academic year, taking into account the update of course content and addition of the most relevant topics was posted to the learning management system (LMS) before the start of semester together with the syllabus and detailed information about peer editing procedure. Students were asked to upload their essay drafts to the learning management system 2 weeks before the final deadline. Students who submitted their texts were grouped into pairs randomly by the instructor. The instructor used a random number generator to assign one number to each student. Then, all students were ranked by these random numbers and then paired. Essays were converted into Google Documents to prepare them for editing. Then each participant received an email with a link to the peer's essay in Google Docs. Before peer editing, a handout about the activity procedure, instructions on how to use Google Docs as the technical tool, and the encouragement of providing comments and tracked changes were given by the instructor. Students had 4 days to go through the essay and provide feedback. After this deadline, the copies of edited essays with feedback were sent to the original authors of texts. Students were given 6 days to reflect on the received comments and/or tracked changes and make any changes in the texts if they found it necessary. Finally, all students were required to upload the final draft to the LMS (no matter whether they participated in peer editing or not). These final versions were sent to professors for further evaluation. Professors provided comments based on their writing performance, and students were given a total grade between 0 and 10.
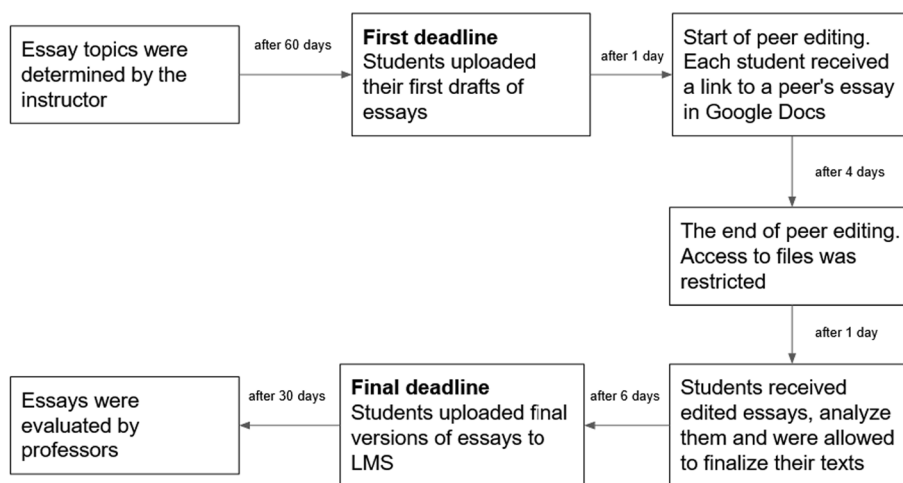

Fig. 1 The diagram of the peer editing process

Research instruments

Comments

For this research comments may be defined as written pieces of feedback given by a peer to an essay in Google Docs. Students may highlight a word or a phrase and add some text explaining their ideas. All comments are arranged in a column in the space to the right of the document. For the present study, the number of comments added to the given peer's text in Google Docs were counted and later used for analysis as a "Total number of comments" variable. We measured the total number of comments from two perspectives: how many comments each student received and how many comments each student provided. This distinction allowed us to evaluate the activity of each student in the peer editing.

Tracked changes

Apart from leaving embedded comments to the document, students could directly make some changes on original text in Google Docs, for instance, to correct spelling mistakes and/or grammatical errors. During the online peer editing, students may choose to add or delete words, phrases, sentences, even paragraphs to each other's writing. For this research tracked changes may be defined as the number of words which were added to the original text or deleted in Google Docs. All proposed changes are automatically highlighted in the text in a different colour. The number of words added and deleted in this format were counted and used in data analysis as "Tracked changes (words added)", and "Tracked changes (words deleted)" variables. In other words, if a student changed information from the original text, the number of these words was counted. Specifically, the number of words that students suggested to add to the original writing to help build the new ideas was counted as "words added", and similarly, the words that the editor removed from the original paper were counted as the "words deleted" variable. This distinction helped to separate two different types of provided changes because of their different functions. "Tracked changes (words added)" variable allows to evaluate the contribution that the reviewer has made to the text, for example, added characters, words, or even entire sentences. However, the added information may not always be in line with the author's original ideas. At the same time, the number of words deleted helps to evaluate the volume of text that the reviewer suggests removing. The first strategy may be more fruitful for the author, as it involves suggesting some ideas or changes. Removing characters may help to correct errors and typos, however, it may be perceived negatively. Therefore, the impact of words added and words deleted should be investigated separately. Furthermore, the total number words added and words deleted were measured from two perspectives: how many changes each student received from their peers and how many changes each student suggested to their peers.

Survey

After peer editing was finished, students were asked to fill in an online survey about their experience in peer editing. We asked them to provide some basic information (age, gender, nationality and GPA) and indicate their agreement or disagreement with different statements using a 7-point Likert scale (where 1 is totally disagree, 7 is totally

agree). There were 4 groups of statements: about their previous peer editing experience, the feedback they provided (for comments and tracked changes separately), the feedback they received (for comments and tracked changes separately), and their opinion about present peer editing experience (see "Appendix 1" for a list of survey questions). The reliability of the scales were measured using a reliability test—Cronbach's Alpha: provided feedback $= 0.71$; received feedback $= 0.95$; opinion about participation in peer editing $= 0.87$.

Writing assignment

The writing assignment was assessed by 4 course instructors on a scale from 0 to 10 using rubrics. Rubrics were developed by instructors of the discipline (see Table 1). The instructors regularly meet to discuss assessment and how to grade assignments. There is general agreement on the scoring criteria. The assignments were all double graded, and if there were any disagreements a third party would grade the assignment as well to reach agreement on each essay's score. The appropriate use of the theoretical frameworks studied within the discipline formed 20% of total essay grade. The quality of gathered information and its subsequent analysis were evaluated as 40% of the total essay grade. Finally, the quality of argumentation formed 40% of the total essay grade. The four instructors discussed the grading criteria at the beginning of the course to develop a consistent framework from which to work through the documents together. Following the completion of the task, the essays were divided among the instructors for grading. Following the first grading, the paper was looked at again, and any issues with a particular paper's grade was resolved through common agreement.

Table 1 Criteria for essay evaluation

Evaluation criteria	Requirements	Max score	Scale
Knowledge and understanding of theoretical material	Key concepts are defined clearly and completely, relevant examples are given The used concepts strictly correspond to the topic	2	2—Fully meets the criteria 1—Needs improvement 0—Inadequate
Analysis and evaluation of information	Methods of comparison and generalization are used to analyze the relationship between concepts and phenomena Alternative views on the problem are presented Textual information and/or data is justifiably interpreted An opinion about the problem is given	4	4—Exceeds expectations 3—Fully meets the criteria 2—Partially meets the criteria 1—Needs significant improvement 0—Inadequate
Judgments	Presentation of ideas is clear and concise The evidence is logical The statements are accompanied by competent argumentation The general form of presentation of the obtained results and their interpretation corresponds to the genre of a scientific article	4	4—Exceeds expectations 3—Fully meets the criteria 2—Partially meets the criteria 1—Needs significant improvement 0—Inadequate

Results

The data were analysed using linear regression, where the dependent variable was students' score on the essay. The main independent variables were the counts of received tracked changes (words deleted), received tracked changes (words added); received total number of comments; given total number of comments; given tracked changes (words deleted); and given tracked changes (words added). The characteristics of the listed variables are shown in Table 2.

The average final score for the essay was 7.95 (SD = 1.5), with a minimum score of 0 and a maximum score of 10 among the participants in the present study. Each student participated in peer editing, provided and received feedback and sent the essay to the instructor. Given and received comments and tracked changes had the same minimum and maximum number of words because they are inverse of each other. However, there were different mean numbers of words because some students did not agree to share data or were excluded after checking the data for outliers. Thus, it explains the discrepancy between the averages.

We controlled for confounding variables such as GPA, gender, age, nationality (Russian or international student) experience with peer editing and students' perception of participation in peer editing. After checking for multicollinearity, we had to remove from the analysis some variables related to students' attitude to the peer-editing activity as they were strongly correlated with each other and we kept the variables with VIF (the variance inflation factor) in the range [1; 2], showing that there are no significant linear relations among independent variables. The final model is presented in Table 3. Positive unstandardised coefficients (B) values indicate a positive association between the predictor and the predicted variable (outcome: final score for the essay), and negative unstandardised coefficients (B) shows a negative association. Increasing the predictor value, there will be an increase (positive associations) or decrease (negative associations) in the predicted variable—in this case, the result of the final score for the essay.

As our results show, there is a positive relationship between the final score for the essay and the total number of received comments (B = 0.034, $p < 0.01$). This means that the more comments students receive from their peers, the better their writing performance. However, the relationship between the total number of received tracked changes (words deleted and words added) and the final score for the essay was not confirmed. In regard to the total number of given comments and tracked

Table 2 Descriptive statistics for the main variables used in the study

	N	Min	Max	Mean	Std. deviation	Description
Final score	147	0	10	7.95	1.456	Points
Received total number of comments	147	0	62	11.85	12.609	Words
Received tracked changes words added	147	0	229	13.78	34.277	Words
Received tracked changes words deleted	147	0	67	4.73	11.131	Words
Given total number of comments	147	0	62	12.90	12.651	Words
Given tracked changes words added	147	0	229	16.39	37.066	Words
Given tracked changes words deleted	147	0	67	5.70	13.028	Words

Table 3 Linear regression estimates

Variables	Unstandardized coefficients		VIF
	B	Std. error	
Intercept	5.94	3.66	
Received tracked changes words deleted	0.011	0.011	1.19
Received tracked changes words added	0.002	0.004	1.24
Received total number of comments	**0.034**	**0.010***	1.27
Given total number of comments	0.006	0.011	1.43
Given tracked changes words deleted	0.005	0.010	1.28
Given tracked changes words added	− 0.001	0.003	1.26
GPA	**0.261**	**0.132***	1.41
Age	0.027	0.172	1.20
Gender	**0.520**	**0.261***	1.35
Nationality	0.068	0.363	1.30
I enjoy taking part in peer editing	0.038	0.090	1.51
Previously (before April 2022) I had experience participating in peer editing	− 0.029	0.277	1.16
The edits from my peers are of good quality	**− 0.221**	**0.069****	1.30
It's more polite to provide comments than to edit others' writing directly	− 0.086	0.109	1.37
I carefully consider the way of expression when I provide comments to others	− 0.014	0.132	1.44
I prefer to provide comments when there are some technical issues like content errors in others' writing	− 0.009	0.077	1.25
I prefer to add comments when there are some content errors in the text. such as illogical paragraph order, incorrect argumentation	0.039	0.101	1.51
I prefer to provide comments with evidence	0.027	0.083	1.42
I prefer to edit others' writing directly when there are spelling or grammatical errors	− 0.006	0.060	1.26

Bolded numbers indicate a statistically significant association

Adjusted R square 14%

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

changes (both words deleted and words added), neither variable had a statistically significant relationship with the final essay score. Therefore, these hypotheses were not supported in this study.

Another result of interest is the negative relationship between the final score for the essay and students' perception of the quality of peers' edits (B = − 0.221, $p < 0.01$). Despite this result being counterintuitive, it can be explained in the following way. Competent students tend to doubt the quality of feedback they receive from their peers because it is more likely that their texts may be edited by less competent peers. Especially in our study, all essays were randomly assigned to students. At the same time students who perform worse are happier with received feedback. For them it is more likely to receive feedback from peers with equal level of competence or even better. Some of the controlling variables, 'gender' and 'GPA', are significant in our model, so they have an impact on students' final score for the essay. It was found that students, who have higher academic results, tend to receive higher scores

for the essay. Also, female students do better in the essays compared to their male counterparts.

Discussion

Although many scientific papers have been devoted to researching online peer feedback, the question about the impact of providing and receiving different types of peer editing (in the form of comments and tracked changes) on student writing performance is still of value to build a fuller understanding of this type of collaborative writing activity. The goal of the current study is to uncover the impact of providing and receiving different types of peer editing (in form of comments and tracked changes) and students' perception of participation in peer editing on writing performance. The results demonstrate that the total number of comments received during peer editing is positively correlated with students' writing performance, whereas for received tracked changes there was no statistically significant relationship. As for giving peer editing (in the form of either comments or tracked changes) there was also no association with writing performance. However, positive quality perception of received tracked changes is negatively correlated with students' writing performance.

The results from the first research question demonstrated that students who received more comments produce better essays. This finding corroborates those of prior studies reporting the positive effects receiving comments on students' writing performance (Ebadi & Rahimi, 2017; Huisman et al., 2017). The detailed feedback may attract student's attention to shortcomings of the text from the reader's perspective (Nicol et al., 2014). Then, analysis of received comments may stimulate its evaluation, critical thinking, problem identification and problem-solving processes (Patchan & Schunn, 2015; Wu & Schunn, 2021). Subsequent implementation of suggested changes may result in the improvement of writing quality (McConlogue, 2015; Nicol et al., 2014). However, some research proved that the effectiveness of received comments may vary depending on their type (Cho & MacArthur, 2010). The difference in effectiveness may be explained by the qualitative characteristics of received comments. While the present study does not look at the contents of the comments, some comments may be written in illogical ways or may not include an explanation or justification for the proposed idea, which makes them difficult to understand. Thus, students should provide polite and detailed comments to make it easier for peers to understand, evaluate and implement them.

The results from the second research question demonstrated that there is no association between receiving tracked changes and student writing performance. This finding contrasts with previous literature where receiving tracked changes may be an effective way to improve quality of the text from a grammar perspective (AbuSeileek & Abualsha'r, 2014). Additionally, this type of peer editing could assist students in understanding things from the viewpoint of the reader and preventing the same mistakes in the future (Birnholtz & Ibara, 2012; Petrović et al., 2017). Turning to peer editing receivers, minimal number of tracked changes may be perceived as a sign of disinterest and result in lower writing performance (Mabbott & Bull, 2006). However, a significant number of received tracked changes may decrease the motivation of the author to further their analysis and may decline the effectiveness of peer editing in general (Tseng & Tsai,

2007). Thus, the combination of mentioned factors could negate the positive impact of tracked changes on writing quality.

The third and fourth research questions addressed the relation between given comments and tracked changes and students' writing performance. However, the findings of the present study found no association between those variables. This contradicts previous papers which highlight the development of problem-detection and metacognitive skills during the process of giving feedback as a reason for potential improvement of writing quality (Nicol et al., 2014; Huisman et al., 2017; van Popta et al., 2017). The results of the present study may be explained by the impact of factors preventing students from providing peer editing. Thus, maintaining a supportive learning environment and providing detailed instructions on how to give constructive feedback in a gentle manner may remove barriers and engage students in the peer editing process.

Finally, the fifth research question addressed the relationship between the perceptions of peer editing as a collaborative learning practice and student's writing performance. The findings revealed no correlation between either previous editing experience or a positive perception of peer editing in general and writing quality. It might be explained by the lack of previous editing experience of students. However, the most surprising result of the present study demonstrates that students who evaluate the quality of received tracked changes as high demonstrate worse writing performance. One possible explanation may be in the perception of the quality of edits, because students tend to underestimate their quality. According to Birnholtz and Ibara (2012), students may perceive primarily grammatical tracked changes as a low-levelled type of peer editing and sign of disinterest because of its simplicity. On the contrary, more complex tracked changes may be perceived as a sign of a high level of peer's contribution. However, this type of peer editing proposes changes without explanation or supportive information which makes it difficult for the author to understand the problem in the text or to find the solution which may lead to low academic performance.

Also, this finding may be due to the fact that students don't improve their texts after receiving even high quality tracked changes for some other reasons. This finding corroborates the work of Blau and Caspi (2009), who claimed that students tend to perceive received tracked changes as a deterioration of the text whereas their contribution to the texts of others is perceived as a source for drafts' improvement. It may be explained by a decrease in the sense of psychological ownership after receiving feedback in the form of tracked changes (even high quality). Moreover, the large number of tracked changes make its analysis and subsequent search for solutions to the identified problems less and less attractive for the author (Mabbott & Bull, 2006; Tseng & Tsai, 2007).

However, the findings of the present study also may be explained in the following way. The average GPA among the participants was 6.98 out of 10, so there were many highly performing students. It is possible that the competent students may tend to doubt the quality of received feedback and the level of editor's competence because of higher probability to be edited by less performing peers. However, competent students provide much better feedback than their less able colleagues (Lin et al., 2001). At the same time students who perform worse may be happier with received feedback. On the one hand, they have a better chance to be edited by their high performing colleagues. On the other hand, even if they receive feedback from a peer with similar competence, they may not

be able to evaluate its quality properly with the level of knowledge they have. Moreover, low performing students may formally participate in peer editing, ignore received feedback but evaluate their experience and the quality of received feedback as high. Thus, instructions are needed to explain to students the benefits of receiving feedback from colleagues of any level of competence and engage them in the process of reflection on received edits.

There is also a positive association between the controlling variables—average GPA or gender of the student—and essay writing performance. It seems that students with higher overall performance tend to perform better in the context of individual writing tasks, which supports the findings of previous studies (Liu & Roohr, 2013; Vella et al., 2016). Interestingly, female students are more successful in writing essays which is consistent with the results of existing research (Furnham et al., 2003; Noroozi et al., 2020, 2022). However, the relationship between writing performance and different students' personal characteristics is not the object of the present study and needs further research.

Conclusion

The present study was designed to uncover the impact of providing and receiving different types of peer editing (in form of comments and tracked changes) and students' perception of participation in peer editing on writing performance. Most prior studies in the field of peer editing have only focused on general aspects of this collaborative activity or have dived into the analysis of specific comment types ignoring tracked changes. Moreover, they have relied on the analysis of qualitative data (mostly interviews). The current research seeks to explore the impact of both comments and tracked changes together with students' perception of peer editing participation on writing performance. One of the most significant findings to emerge from this study is that receiving more comments during online peer editing is an effective mechanism for further improvement of students' writing performance. However, there was no correlation between received tracked changes or given feedback (in form of comments and tracked changes) and students' writing performance. The second major finding is that students who evaluate the quality of received tracked changes as high demonstrate worse writing performance, which may be due to the nature of tracked changes as a form of feedback.

The results of this research provide insights for instructors designing and implementing online peer editing sessions in courses. Firstly, Google Docs or a similar platform may be used for organisation of student writing collaboration. It may help students to develop their writing skills as well as instructors to manage the process and to monitor the contribution of every person to peer editing. Moreover, this platform allows to automatically collect digital footprints of students (comments and tracked changes) for its subsequent analysis (Wang et al., 2015). This feature may help instructional designers to better understand the process of online collaboration and implement instructional design techniques to enhance student writing. Secondly, students should be encouraged to provide comments as the most effective form of peer editing. Moreover, after receiving it they should be stimulated to further analysis, evaluation, and implementation of proposed ideas (where it is necessary). Thirdly, maintaining a supportive learning environment and providing detailed instructions on how to give feedback may help to remove barriers and engage students in peer editing. Demonstration of good examples

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of edited documents and discussion of key principles of providing feedback may stimulate students to give more feedback and do it in a more constructive way. Moreover, it may be helpful to discuss with students the potential of feedback in the form of tracked changes. It may help to overcome resistance to direct editing and potentially reduce the impact of the student's negative beliefs about this type of peer editing, which could increase its impact on text quality. Finally, it is necessary to discuss with students the benefits of receiving feedback from colleagues of any level of competence. It allows one to see the text from the reader's perspective and find some writing structures that need work. This recommendation may help to reduce the resistance of high performing students and engage them in the reflection on received feedback. Moreover, further research should be undertaken to focus on the research of different categories of comments and their impact on writing performance.

Although the study contributes to our understanding of students' writing performance improvement in an online environment with the help of online peer editing sessions, it has some limitations. Firstly, the number of comments and tracked changes suggested in Google Documents were used as the only indicator of collaboration between students during peer editing. However, communication with the help of email, instant messengers or video conferencing services wasn't considered. The collection and analysis of data from different communication channels would likely provide many insights about peer editing. Finally, the current research is focused on the number of comments and tracked changes ignoring the qualitative characteristics of peer editing. Thus, a further study could assess the effects of both the quantity and quality of comments and tracked changes on writing performance. Therefore, this study can serve as a solid foundation for a future study on the quality of students' feedback. Moreover, future research with experimental design may explore the causality between types of peer editing and students' writing performance.

Appendix 1

List of survey questions

Please check this box with "agree" if you are happy for us to use the information we gather about peer editing to conduct research and improve the learning experience of students at HSE.

- Agree
- Disagree

General information (open questions).

(1) Surname, name
(2) Gender
(3) Age
(4) Major
(5) Nationality

(6) GPA

(7) Email

(8) Previously (before April 2022) I had experience participating in peer editing (Yes/ No)

Using the scale below, indicate to what extent you agree or disagree with following statements (from 1—Strongly disagree to 7—Strongly agree).

No	Statement	1	2	3	4	5	6	7
	Peer editing experience							
8	I enjoy taking part in peer editing							
	Provided feedback (comments and tracked changes)							
9	It's more polite to provide comments than to edit others' writing directly							
10	I carefully consider the way of expression when I provide comments to others							
11	I prefer to provide comments when there are some technical issues like content errors in others' writing							
12	I prefer to add comments when there are some content errors in the text, such as illogical paragraph order, incorrect argumentation							
13	I prefer to provide comments with evidence							
14	The comments I provide to other students are of good quality and can help them improve their writing skills							
15	Providing comments to others' writing is useful to improve my own writing skills							
16	I prefer to edit others' writing directly when there are spelling or grammatical errors							
17	I like to browse the full text, find the marked errors in Google Docs, and edit them directly at the first beginning							
18	I am confident that my edits of others' writing are of good quality							
19	Providing changes to others' writing is useful to improve my own writing skills							
20	The comments I received from my peers are of good quality							
21	I can easily understand the meaning of comments from my peers							
	Received feedback (comments and tracked changes)							
22	The comments I received were polite and neutral							
23	I agree with the comments from my peers							
24	I seriously considered the comments provided by my peers and then revised my own writing							
25	Comments from my peers can help me improve my writing skills							
26	The edits from my peers are of good quality							
27	I agree with the edits from my peers							
28	I considered the edits provided by my peers and then revised my own writing							
29	Edits from my peers can help me improve my writing skills							
	Opinion about participation in peer editing							
30	When I go through other essay, I also reflect on whether there are similar errors in my text							
31	When comments provided by my peers are ambiguous, it would be good discuss the comments with them							
32	I liked to take part in this peer editing activity							
33	Participation in peer editing was helpful for me							
34	Participation in peer editing helped me to make my essay better							
35	I don't mind taking part in peer editing activities in the future							

Author contributions
Galina Shulgina: Wrote the original draft of the paper; Jamie Costley: Organized the conceptual framework of the paper; Irina Shcheglova: Conducted the analysis used in the paper; Han Zhang: Worked on the rewrite and revision of the paper; Natalya Sedova: Conducted the experiment.

Availability of data and materials
The datasets generated during and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Declarations

Competing interests
The authors have no competing interests to declare.

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