Advances in Language and Literary Studies
ISSN: 2203-4714
www.alls.aiac.org.au

Collaborative Writing on Google Docs: Taiwanese Students' Participation, Behaviors, and Writing Trajectories with Real-work Online Tasks

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ARTICLE INFO

Article history
Received: February 13, 2021
Accepted: April 10, 2021
Published: June 30, 2021
Volume: 12 Issue: 3
Advance access: June 2021

Conflicts of interest: None
Funding: None

Key words:
Collaborative Writing,
Second Language Writing,
Collaborative Patterns,
Writing Change Functions,
Google Docs

ABSTRACT

In the past two decades, the growing rage of computer mediated environments (CMC) affords new literacies and new opportunities for language learners to experience, construct, communicate, and access knowledge (Ware, Kern & Warschauer, 2016). Also, it suggests that writing in multimodal in the digital ear contributes to its production and interpretation (Canagarajah, 2013) and can be particularly beneficial for L2 learners' writing practices (Elola & Oskoz, 2010) such as writing quality (Stroch, 2005), writing fluency (Bloch, 2007), academic voices (Sperling & Appleman, 2011) and a sense of audience (Sun & Chang, 2012). Google Docs and online text-chat systems are prominent collaborative tools for group writing, and the result shows that the focus group displayed a mixed-interaction pattern, a collaborative pattern in two online text-chat systems, and a more dominant-passive pattern while co-constructing the text. They study also explored that changing the mode of communication from Line to Google Docs chat-room appears to have led to an increase in the participants' interaction and communication and seems to have facilitated collaboration. Participants make a significant contribution of two types of writing changing functions, adding and correcting in the text and make revisions to their text.

INTRODUCTION

Collaborative writing is on the increase and has become an instructional activity in higher education contexts. Students are expected to learn collaboratively in language learning contexts since collaborative activities are considered one of the measures to reach the objective of communicative language learning and apply in cross-disciplinary or content knowledge learning (Hirvela, 2011). With the growing awareness of beneficial collaborative work in the development of language skills or content knowledge, the wide range of language learning studies has been underpinned by the adoption of influential theoretical parts of second language acquisition or the sociocultural theoretical approach as a framework. Much research has been conducted to examine the role of language itself or learners' motivation, negotiation, and interaction in the learning process and language learning contexts. From a sociocultural perspective, Vygotsky (1978) claimed that cognitive skill development through interacting with others, so the concept of scaffolding is particularly adopted as researchers attempt to explore learners' interaction and collaborative processes.

Technologies have transformed the ways learners experience, construct, communicate, and access knowledge (Ware, Kern, & Warschauer, 2016). Social technologies in Web.2.0 environments, such as wikis, chatrooms, and Google Docs, for communication and collaboration have been increasingly implemented in language learning classes and have brought renewed attention to L2 collaborative writing (Elola & Oskoz, 2010; Kessler & Bikowski, 2010; Estaji & Salimi, 2018). Some researchers have also suggested that multimodal writing in the digital era contributes to its production and interpretation (e.g., Canagarajah, 2013; Elola and Oskoz, 2010) and can be particularly beneficial for L2 learners (e.g., Storch, 2005; Bloch, 2007; Sun and Chang, 2012). Many researchers have investigated the influence that patterns of interaction in the process of web-based collaborative writing have on the quality of joint texts (e.g., Elola & Oskoz, 2010), and learners' perceptions of online collaboration (e.g., Chao & Lo, 2011; Li & Zhu, 2013). Among these research areas, relatively fewer studies have investigated interaction patterns (Storch, 2013) in web-based learning contexts or the factors that influence web-based collaborative writing practices through expanding authentic and meaningful discourse (Warschauer, 1997; Elola & Oskoz, 2010). Therefore, the present study aimed to advance our knowledge of Taiwanese students' specific contextual factors (e.g., roles,

Published by Australian International Academic Centre PTY.LTD.

http://dx.doi.org/10.7575/aiac.alls.v.12n.3.p.73

writing change functions, number of editions, revisions) and collaboration-related behaviors (e.g., students' participation, behaviors, and writing trajectories) in a synchronous writing task via Google Docs. The following research questions guide the study: 1) What patterns of interaction occur and the collaboration-related behaviors related to writing quality and quantity of the focus group in the synchronous writing process and outcomes in Google Docs? 2) How do students in a small group co-construct written texts via collaborative writing via Google Docs? The study was expected to shed light on the dynamics of group interactions across the complex collaborative process of cloud-based writing tasks.

LITERATURE REVIEW

Technology in Foreign Language Writing

Keeping up with the 21st-century technology literacy demands, communication technologies are rapidly reshaping our understanding of literacy, "forcing us to reconceive the nature of written media and the writing activity" (Canagarajah, 2002, p. 211). Some researchers have emphasized the need for educators to develop new digital literacies for academic or career purposes (e.g., Koehler, Bloom, & Milner, 2015) and create new opportunities for writing practices (Elola & Oskoz, 2010). L2 researchers also have argued for the conceptions of expanding multiple modes (Canagarajah, 2013) and have addressed the need to re-conceptualize writing as a multimodal design to assist learners' writing quality (Storch, 2005), writing fluency (Bloch, 2007), and a sense of audience (Sun & Chang, 2012). The most compelling reason for doing so may be that, in the digital era, writing already is and will almost certainly become more so in the future.

Therefore, applying multiple modes and using digital technologies of social tools (e.g. wikis, Google Docs, social networking, blogs) as an essential part of the curriculum in language settings has captured researchers' attention. Second language (L2) researchers have centered on the effectiveness of technology applications in language learning through interactionist and sociocultural theories (e.g., Storch, 2002, 2004; Swain & Lapkin, 1998; Li & Kim, 2016) and the development of new digital genres or literacy (e.g., Belcher, 2017; Elola & Oskoz, 2010; Zheng & Warschauer, 2017; Yim & Warschauer, 2017; Hafner, 2014, 2015; Nanni & Pusay, 2020). Drawing on interactionist and sociocultural aspects of language learning in computer mediated environments (CMC), technologies allow language instructors to take on facilitators' role to increase students' active engagement in their learning process (Kelm, 1996) and to choose their social roles. These digital technologies have the potential to transform what is often teacher-centered communication into more multidirectional interaction in computer-mediated contexts.

Research Studies: Collaborative Writing and Writing Online

With the advent of Web 2.0 technologies, new ways of interacting and collaborating have shifted the teaching pedagogy to rethink and move toward a more expanded view of language learning (Chun et al., 2016). As previously mentioned, educators can access considerable communication sources and construct and produce knowledge (Ware, Kern, & Warschauer, 2016). Therefore, writing is not typically thought of as an individual activity in the classroom; widely used software or applications (apps) have been designed and serve to help writers interact online and empower communication and collaboration through the cloud. During the late 1980s and early 1990s, collaborative writing attracted the attention of many researchers from different domains. In 1992, Posner and Baecker proposed a taxonomy of collaborative writing styles, including roles, activities, document control, and writing strategies. Following on collaborative writing researchers, Storch (2002) and Watanabe (2008) examined patterns of interaction in pair writing by setting up mutuality and equality with four different interaction patterns, and they found that the collaborative pattern of expert/novice was more conducive to students' language learning than others.

In the past decade, a great deal of research in collaboration and communication in computer mediated environment (CMC) has been increasingly implemented in language learning classes. It has continued to draw a great deal of research attention in second language writing (L2) contexts. Applying collaborative writing within a small group writing task environment (e.g. Li & Zhu, 2013; Storch, 2002, 2004; Swain & Lapkin, 1998) to create more opportunities for L2 students to review and apply the content knowledge they have learned (Hirvela,1999) to produce written output. Other aspects in the writing process such as the quality of joint texts (e.g. Elola & Oskoz, 2010), multimodal feedback (Elola & Oskoz, 2016), the textual features of co-constructed texts (e.g. Elola & Oskoz, 2010), and learners' perceptions of online collaboration (e.g. Chao & Lo, 2011; Li & Zhu, 2013) also have been investigated. Among these research areas, relatively few studies have investigated interaction patterns (Storch, 2013) in computer-mediated communication (CMC) and the factors which influence web-based collaborative writing practices through expanding authentic and meaningful discourse (Warschauer, 1997; Elola & Oskoz, 2010). Yim and Warschauer (2017) suggested the need to capture online writing's quantity and quality in a collaborative environment.

In order to gain insights into the complex collaborative process of interaction and writing trajectories in web-based learning contexts, this mixed-methods study aimed to advance our knowledge of Taiwanese students' specific, e.g. roles, writing change functions, amount of edition, revision) and interactional patterns by analyzing their collaboration-related behaviors (e.g. total numbers of writing in turns, evenness of participation) in the synchronous writing process and outcomes in Google Docs.

METHODS

In this mixed-method study, the researcher applied cloud-based text mining and visualization techniques to support an in-depth qualitative investigation and provide important usage statistics to gain rich insights into students' partici-

pation and perceptions of collaborative writing and writing trajectories. The text mining techniques can illustrate the group's collaboration-related behaviors such as communication and interactions among participants to create a holistic picture.

The Setting and Participants

The study recruited participant groups who expressed interest in participating in collaborative writing at one University in Southern Taiwan and applied multimodal writing activities and tasks in cloud-based platforms such as Google Docs as L2 writing resources in two naturalistic contexts. I recruited sophomores who were taking a second language intermediate writing course. The participants were divided into five small groups of three or four, formed based on the free choice of partners, but minor adjustments were made based on language proficiency levels in the hope of providing students with more opportunities to scaffold each other and engage in more meaningful negotiations in the L2 (Storch, 2013).

The multimodal writing activities and tasks were used in the composition class and conducted on the cloud-based platform, Google Docs, the functions of this social software were essential factors for the researcher to consider. All participants were required to learn and practice several functions available at no charge on Google Docs, including synchronous and asynchronous viewing, editing, and commenting on any document by multiple contributors on different computers. Participants also used a revision history function to check the author's edition and revert to an earlier version if they disapprove of a change. After online reading and researching sources, the participants discussed and decided on their topic and completed the web-based collaborative writing task on Google Docs. They had three weeks to complete the task.

Data Collection

Data were collected through qualitative documents, questionnaires, and essay writing. The writing task lasted for five weeks. Before introducing the Google Docs collaborative writing project, a pre-task questionnaire survey was given to the students to complete individually. Two weeks of preparation included introducing the Google Docs collaborative writing project and learning to use the online writing platform, followed by one week of online research and group discussion on two text chatrooms in week 3. Data consisted of students' documents written on Google Docs and each participant's entire revision history and tracked changes of Google Docs to visualize the revision histories of each participant in a particular slice of time. Collaborators could rewrite and amend the documents, which were saved automatically, and all previous versions could be retrieved through the revision history function, which made the changes transparent.

Before the follow-up interview, the researcher collected the online text-chat data in multiple modes of communication. After completing the writing project in Week 5, the post-task questionnaire survey and reflection papers about individual contributions were administered to investigate and compare participants' attitudes towards and perceptions of collaborative writing. The two rounds of follow-up qualitative interviews were held in Week 6 to clarify participants' text-chat data and online written text, which was followed by the qualitative data analysis and coding.

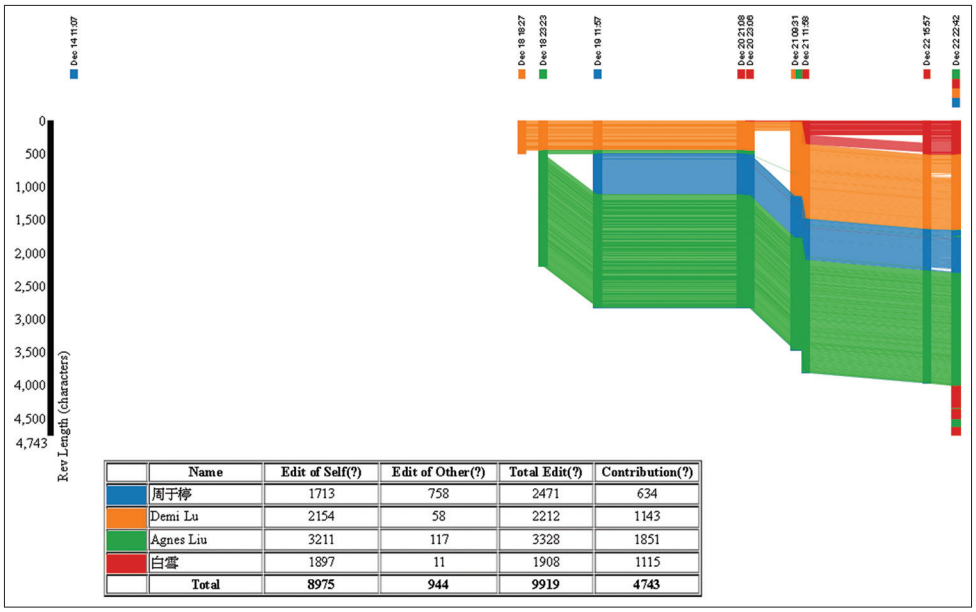
Data Analysis

Data were analyzed from the visualization of the participants' revision histories, the text-chat, written text, and pre- and post-task questionnaires to investigate students' collaborative-related behaviors. In-depth qualitative analyses were supported by quantification and collaboration using text mining techniques called DocuViz and AuthorViz. Two open-source text mining tool were used to measure the length of the document, illustrate the layout of the amount of contribution each person made, and understand the patterns of interaction occurring in each group and their collaboration-related behaviors in the cloud-based writing system (e.g., Yim & Warschauer, 2016; Wang, 2016).

DocuViz (Figure 1) is an interactive visualization system that provides usage statistics (e.g. authorship, amount, and timing of revision). Using the function of History Flow, the researcher can understand who made the additions and deletions over time. At the top of the vertical bars shown by colors are the slices with authors noted, the columns represent time moving from left to right, and the amount of their contribution is the size of the bar. The slices on a timeline show who was inactive, and bursts and delays of activity at any moment. The number of characters contributed to the final document is shown at the bottom of the chart.

Language becomes a semiotic tool that mediates the interaction between the group members and their relationship and the degree of control over their language use. Therefore, the second open-source text mining tool used in the study, AuthorViz (Figure 2), is another useful visualization tool for analyzing collaboratively written paragraphs and identifying writers' linguistic contributions. Different colors denote each contributor's writing, indicating their roles, contribution, language use, and editing support in Google Docs (Wang, 2016). These two advanced visualization tools help the researcher measure and depict a group's collaboration behaviors to elucidate the quality of each author's linguistic contribution and language use.

I modified a taxonomy of five types of writing change functions (adding, deleting, correcting, rephrasing, and reordering) proposed by Mak and Coniam (2008) and expanded by Li (2013) revealed in the Google Docs History records (i.e. adding, deleting, correcting, expanding, paraphrasing, and reorganizing) to analyze the ways in which students in a small group co-constructed a written text in Google Docs, the language used among the group members to mediate the interaction, and their relationship while they negotiated their meanings. The text-chat data in multiple modes of communication for all groups were collected and open-coded (Corbin & Strauss, 2008) after the group had completed the writing task. Online text-chat engagements and conversations were segmented into words, turns, and expansion of discourse on



	Name	Edit of Self(?)	Edit of Other(?)	Total Edit(?)	Contribution(?)
	周于檸	1713	758	2471	634
	Demi Lu	2154	58	2212	1143
	Agnes Liu	3211	117	3328	1851
	白雪	1897	11	1908	1115
	Total	**8975**	**944**	**9919**	**4743**

Figure 1. The user view of docuviz results for an example text

How to Prevent the Forest Fire
Recently, the catastrophic forest fire in California has been burning for two months. Then, the fire blazed and destroyed the thousands of buildings and farms. Even though the wildfire didn't cause heavy casualties, it still had a huge impact on local residents. Frankly, it is not the first time for this kind of thing to happen. The research shows that approximately 220,000 forest fire happened each year. Because of that, it makes us wonder that do we really know how to prevent the forest fire.

Figure 2. Authorviz view in Google Doc for an example text

the same topic (Storch, 2001) to view how the small group co-constructed the written text. To measure the quality, I constructed a rubric for three composition instructors to evaluate the documents in terms of their completeness, clarity, and format.

RESULTS

Analysis of the Interaction Patterns

The study results present only one focus group performing their collaboration-related behaviors related to writing quantity, the group's interaction patterns, and the individuals' language use in the synchronous writing process and outcomes in Google Docs.

Patterns of contribution

As shown in Table 1, the four participants' online text-chat indicated their interaction patterns, communications, and contributions during the writing process regarding the total number of turns and the total number of words in each turn in the two text-chat systems.

In the Line chat-room, Alexandra, Ken and Jennifer produced a similar number of turns and contributed similar amounts of text, while Anny only produced 19 turns with 55 words, which was not as much as the others. Alexandra did not participate in the group discussion; the other co-authors, Jennifer, Ken and Anny, respectively, wrote 380, 543, and 245 words. Comparing the two online text-chat modes, the participants seemed to prefer interacting in the Google Docs Chat-room, as they produced 122 turns with 1,168 words. From the total number of turns and words, Ken produced the highest number of turns and words in turns in both systems. Anny, on the other hand, produced an average of 5.8 words per turn in the two text-chats. Ken wrote almost twice as much as Alexandra and Anny. The mode of communication from Line to Google Docs chat-room appears to have led to an increase in participants' interaction. The qualitative data reported mutual interaction, discussion, and negotiation primarily on the topic and content aspect in the two types of text-chat. Jennifer seemed to get everyone involved in the topic and content discussion at the beginning.

Analysis of Writing Change Functions

Table 2 identifies the five types of writing change functions in the collaborative writing project corresponding to Li's (2013) study to illustrate the text co-construction of the collaborative writing. Based on Li and Kim (2016), I listed a taxonomy of writing change functions found in the writing text and displayed in Table 2. The data in Table 2 were displayed on the participants' own Google Docs space. The Google Docs History Flow function could be observed and understood who did the adding, deleting, rephrasing, reordering, and correcting of their own or others' work over time.

The four group members made 49 writing change acts, including 16 instances of adding, nine instances of deleting, one instance of rephrasing, three instances of reordering, and 20 instances of correcting. They frequently performed the language functions of adding (16 out of 49, 32.65%)

Table 1. Numbers of words in turns and words per turn

Participants Types of text-chat	Jennifer	Alexandra	Ken	Anny	Total
1.Line					
Total number of turns	28	34	34	19	115
Total number of words in turns	194	219	227	55	695
2.Google Docs- Chat Room					
Total number of turns	41	0	48	33	122
Total number of words in turns	380	0	543	245	1168
Total number of turns in two text-chat	69	34	82	52	237
Total number of words in two text-chat	574	219	770	300	1863
Average Words per turn.in two text-chat	8.3	6.4	9.4	5.8	7.9

The student names are pseudonyms

Table 2. Category of writing change functions in the text

Language functions	Edit of	Jennifer	Alexandra	Ken	Anny	Total
Adding	Self	5	1	5	5	16
	Other	0	0	0	0	0
Deleting	Self	1	0	2	1	4
	Other	2	0	2	1	5
Rephrasing	Self	0	0	1	0	1
	Other	0	0	0	0	0
Reordering	Self	0	0	1	1	2
	Other	1	0	0	0	1
Correcting	Self	1	0	5	3	9
	Other	3	1	5	2	11
Total		13	2	21	13	49

and correcting (20 out of 49, 40.82%). The four participants specifically performed additions in their own written text and correcting other text (11 out of 49, 22.45%), but they never performed language functions to add and rephrase other text. Writing change functions showed the degree of mutuality of their interaction and their preference of language used while writing collaboratively. Jennifer performed 13 instances of writing change functions, Alexandra two, Ken 21, and Anny 13. The highest occurrence of writing change functions shown in the text was Ken (21 out of 49,42.86%), Jennifer and Anny both made 13 (27%), and Alexandra made the least writing change functions of all (2 out of 49). Ken made the most contributions and performed diverse types of change functions. Among the total of 49 writing change acts, the participants made more revisions to their text (32 out of 49, 65%) than to others' work (17 times; 35%). Despite the individual contributions to group writing, the four participants did not demonstrate equal co-ownership or coordinated efforts. Ken and Anny added, deleted, reordered, and corrected their texts and engaged with other members' texts by deleting and correcting. Jennifer showed a higher degree of reciprocal responses by deleting, reordering, and correcting partners' texts. Alexandra's collective efforts were minimal and reflected in fewer instances of responded language functions from the other three group members, ending up merely adding one topic sentence. The writing change functions showed that the degree of mutuality of their interaction and co-ownership was not equal, and their preferences and writing skills were slightly different.

Another way to display participants' writing contributions and outcomes were from the View of DocuViz results. Table 3 shows a simple calculation of characters in the final version produced by each of the authors.

REV LENGTH (CHARACTERS) FROM THE VIEW OF DOCUVIZ RESULTS

The quantity of contribution showed that Ken did a significant amount of edition of his own and others' writing, with a total of 13,995. However, the total amount of contribution was only 700 characters. Alexandra made fewer editions and contributions to the final document. Although the table shows the most immediate information of how much each author contributed to the collaborative writing process, one point could be misleading. Jennifer copied Ken's work and pasted it into the final version, and this paste lost the attribution of original authorship and assigned it to Jennifer. Ken copied the work from other working documents and pasted it into the text. Jennifer and Ken's total editions and contribution could be miscalculated, distorting the figures regarding how much of the final document was contributed by each author. The quantity of self or other edition corresponds to the num-

ber of writing language change functions they performed in the written text.

View of a Collaboratively Written Paragraph

The data shown in Figure 3 presents a visualization of the collaborative written text using the document visualization tool DocuViz to link and elucidate the writing patterns and authors' linguistic contributions in the synchronous writing process.

From the final writing layout of the AuthorViz view of the collaboratively written paragraph in Google Docs, Ken's writing is indicated in blue, and that of Anny, Jennifer, and Alexandra is indicated in orange, green, and red, respectively. Ken generated the topic, and Jennifer provided suggestions and corrected it. In paragraph one, Anny and Jennifer made a great contribution to editing the topic sentence. Ken said," In the essay, I have to write the first paragraph and try to work on statement. For topic sentence, Anny, Jennifer, and I have been discussed and revised several times. Even though my group members slightly edit my topic sentence, they did a great contribution in generating ideas." Two days later, Anny added content to paragraph two and Ken edited it with a special focus on morphological features to help determine the part of speech and syntactical functions, adjective clauses and transitional signals to make the meaning more cohesive. Anny stated that,

> My writing skills are not quite mature, so I made many grammatical errors such as tense or adjectival clauses. My group members remind me and help me to edit my part. I also learn from their writing skills and accept their advice. I appreciated my partners, especially Ken, because he helps me modify sentences and use transitional signals to make the meaning and the paragraph more cohesive, such as Then, Also, Therefore.

Jennifer further explained that she did not revise a lot from paragraph 3 nor other paragraphs because she was busy with her part-time job. Jennifer completed her part and showed less reciprocal engagement with each other.

Paragraph 4 involved more interactions among the co-authors, and the language functions included correction, deletion, and spelling. Referring to the quantity of writing change functions in the text shown in Table 2, the AuthorViz results visualize the degree of mutuality of their interaction, edition, and co-ownership. Ken, Anny, and Jennifer co-constructed paragraph four, so they frequently interacted on Google Docs and discussed the chatting room. Anny made a great contribution to the first draft and conclusion sentence. Anny also pays special attention to cohesion with the transitional signal. Ken edited and corrected in lexical and syntactical parts. The final sentence ken revised, " I truly hope that people can become wide awake and face up to this significant problem together someday." Ken used the first personal singular pronoun to voice his point instead of using the first plural pronoun to keep her authority firmly. And Jennifer added the word significant to emphasize the problem and establish facts. The use of the first personal singular pronoun Ken explained,

> I did not realize the use of I or We in the last sentence. While I was writing, I tried to complete the sentence

Table 3. A compilation of the number of characters

Name	Edit of Self	Edit of Other	Total Edit	Contribution
Jennifer	2731	1762	4493	1188
Alexandra	593	57	650	0
Ken	12396	1599	13995	700
Anny	3817	450	4267	815
Total	19537	3868	23405	2703

Rev Length (characters) from the View of DocuViz results

How to Prevent the Forest Fire
Recently, the catastrophic forest fire in California has been burning for two months. Then, the fire blazed and destroyed the thousands of buildings and farms. Even though the wildfire didn't cause heavy casualties, it still had a huge impact on local residents. Frankly, it is not the first time for this kind of thing to happen. The research shows that approximately 220,000 forest fire happened each year. Because of that, it makes us wonder that do we really know how to prevent the forest fire.
The severity of forest fire may beyond people's imagination. There are many sorts of factors that can lead to the forest fire, such as lightning and the extremely dry weather. Another aspect, the man-made premeditated arson and the accidental fire which will cause the wildfire. One way or the other, these can have grave consequences. For example, the gases from combustion will cause air pollution. Also, the habitats of flora and fauna will be destroyed. Then, all surrounding places need to be reestablished. Therefore, the aftermath is so horrible that we have more authentic reasons to face and prevent it.
Prevention is better than cure. Nevertheless, how it? First of all, the government should make a law of deforestation to conserve soil and water that decrease the natural causing possibility. Also, we should reduce greenhouse gases emission to make sure that the extremely weather will not happen again. In addition, in order to reduce the artificial factors to cause the forest fire, I think the government should be the role of controller to formulate the regulation of fire and increase the police presence in the forest. Moreover, publicizing the propaganda of protecting forest can make people to know how important the forest is. Furthermore, we can build hierarchical protecting organization to help us control rapidly when the fire starts to spread. At last not least, it is also a prevention to plan the fire break in the forest. When the burning range extend, the fire break can block the fire overspread and as the escape routes.
Finally, no matter is manmade or naturally caused the forest fire, this issue is worth and necessary attaching importance to face. In recent years, global warming leads to abnormal climate conditions. Some areas had excessively sizzling hot and dry weather, and it would cause the forest fire possibly. However, the truth is that everyone knew that this problem is very serious and with no hope of reprieve, but most of people still consider as nonsense and ignore about this problem. I truly hope that people can wide awake and face up to this significant problem together someday.

Figure 3. Authorviz view of a collaboratively written paragraph in google docs

and did not seem to be aware of it. My partners did not edit or change it. Here, I may say I want to use I as an explicit way to express the meaning more subjective and keep our voice and authority even though I was not aware of the ambiguity between the inclusive and exclusive meaning of using we.

There were still some ambilocalities showing in the final writing layout of the AuthorViz view in Google Docs; therefore, participants' descriptive data in their own words or voices can clarify and have an insight into each writers' works and writing behaviors.

View of the DocuViz Results

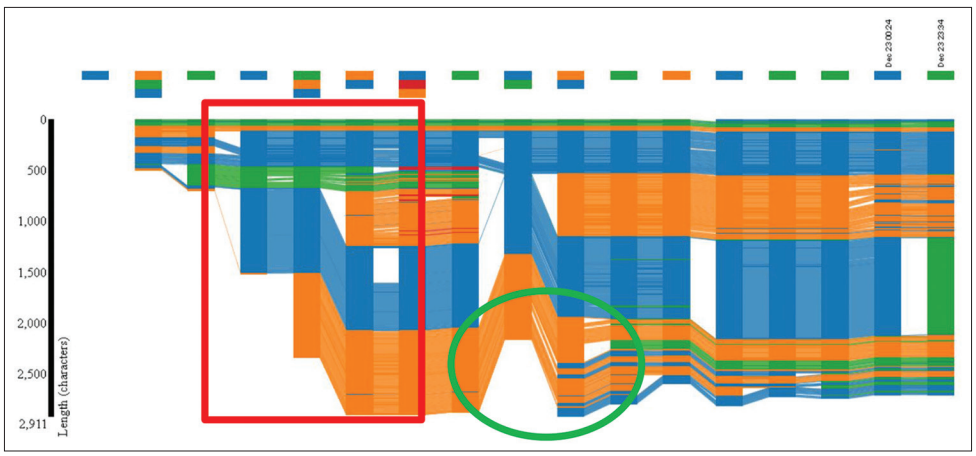
As shown in Figure 4, the four participants are shown by the little bars of color at the top of the columns in that slice of time. Ken is indicated in blue, and Anny, Jennifer, and Alexandra are indicated in orange, green, and red, respectively. The visualization (indicated in the red square) reflects in the slice of time how the writers coordinated synchronously in terms of adding, correcting, and reordering information in paragraphs 1 and 2. Ken, Ken, Anny, and Jennifer participated 3 times in online writing and showed equally reciprocal engagement. However, Alexandra only appeared once to provide an idea for the topic sentence in paragraph 2 and wrote, "Prevention is better than cure."

Ken and Anny added information and made a great contribution and significant progress with the text. There were more frequent writing change functions (indicated in the Green Circle) after a huge amount of deletion from Ken. Ken, Anny, and Jennifer increased their engagement in each other's text construction in paragraph 4. Alexandra's collective effort was minimal and involved unbalanced individual contributions and few reciprocal responses to the others' writing efforts. On the other hand, the other three group members took a collaborative stance and interaction, showing individual accountability in completing their own and reciprocal engagement. The frequency of online collaborative writing showed that Ken constructed the text online frequently with 10 times, Anny 6, Jennifer 9, and Alexandra one. The visualization to reflect the bars of color at the top of the columns reflected how writers sufficiently coordinated synchronously or asynchronously. Even though Jennifer made 9 times of participation and contributions on Google Docs, previous data From AuthorViz showed that she just tried to complete her part and showed less reciprocal engagement. On the other hand, Ken and Anny showed sufficiently coordinated synchronously for their collaborative writing and frequently interacted and engaged with other team members.

DISCUSSION

This mixed-methods study presents Taiwanese students' specific contextual factors and their collaboration-related behaviors. I have drawn on sociocultural theory to gain insights into the group online collaborative writing process by examining interaction patterns in text chat and writing change functions. The following findings are organized according to the two guiding research questions. In the synchronous writing process, I found that the four group members demonstrated different approaches and roles in the writing task. Ken, Anny, and Jennifer showed a collective and active approach to the task by frequently participating in the online discussion, and their interaction did not switch withdraw due to Alexandra's absence.

Conversely, they developed a collaborative stance to complete the task and took their own roles as a leader, facilitator, or coordinator. With the reduced participation from Alexandra and less contribution among group members in the two types of text-chat, Ken took more control over the task and played the role of leader, while Jennifer and Anny contributed actively and equally to the task. Jennifer gave other group members instructions on how they should complete their project and what they should follow based on the task's rules and requirements. Alexandra took on the role of a participant to provide feedback and ideas for the organization. Anny, quite the contrary, played a more passive role as coordinator in the group discussion. Ken adopted a leadership role that helped negotiate meaning, organize the writing task, and make the collaborative writing process (Yang, 2014) smoother. I attributed the group interaction patterns to their positive collaborative manner when making decisions, negotiating meaning, showing their goals (Storch, 2004), and accepting their roles, and building on each other's ideas.



AQ1 **Figure 4.** View of the docu viz results

In addition to the interaction patterns in the text-chat rooms, the mode of communication influenced the quantity of the present participants' collaborations. Comparing the two online text chats, Google Docs Chat-room was perceived to facilitate participant collaboration more efficiently because of its history and tracking changes in Google Docs.

The ways the members jointly produced writing can be explained by the textual features of co-constructed text and writing changing functions. I detected some instances of correcting functions during text co-construction where learners questioned their own or others' language use for elaborating negotiation of language use. Additionally, multiple functions of writing discussion on content topics, ideas, and genre structures were found. I explain this finding by the participants' unfamiliarity with the genre and with academic writing skills and their uncertainty about language use. For example, the participants took up a greater proportion of the time to discuss grammatical accuracy and lexical choices but could not add or rephrase each other's texts. In other words, one may not accept or integrate group members' suggestions into one's writing text, especially with insufficient knowledge or when not trusting one's partners' language proficiency. Consequently, the four participants were more engaged in the discussion about lexical selection and structure correction, and they eventually reduced the writing change functions of others and possessed a strong sense of ownership and uncertainty of language use.

CONCLUSION AND IMPLICATIONS

The study specifically evaluated the group's interaction patterns and collaborative-related behaviors with respect to dynamic interaction processes driven and affected by specific factors such as roles, the modes of communication, the degree of mutual interaction, contributions, writing changing functions. Collaborative writing tasks in a Google Docs environment constitute sociocultural sites for learners' repeated practice in deliberating on and negotiating their ideas in co-constructing a text involving time, roles taking, and self or other group members' motivation. As Storch (2002) argued, language mediates the interaction between group members, but it also negotiates their relationship. Language learning requires a great deal of time and practice, so collaborative writing activities afford students opportunities to learn, discuss or negotiate meaning either in harmony or in conflict, and eventually enhance second language writing. Returning to Storch's (2002) four interaction model in a second language (L2) setting, the focus group displayed a mixed-interaction pattern, a collaborative pattern in two online text-chat systems, and a more dominant-passive pattern while co-constructing the text.

This study enhances instructors' awareness of the importance of associating with specific digital genres in the digital era and methodologically contributes to the literature on collaborative writing in L2 writing pedagogy. Recent scholarship has also addressed the need to reconceptualize writing as a multimodal form of communication and collaboration in web-based contexts and engage students in collaborative writing projects in the EFL writing classroom. As for educators and instructors, it is vital to rethink how to shift and transform the teaching paradigm and reshape their teaching methods. Collaborative writing in cloud-based language learning environments potentially enhances L2 writing processes and outcomes in different ways. It can be considered and applied extensively as a knowledge-making activity to elicit students' talk, ideas, and interactions between group members and to negotiate their relationship.

Second, CMC technologies should be carefully selected according to task purposes, particular objectives, and learners' language proficiency. As Thorne and Reinhardt (2008) argued, applying a digital task requires understanding communication theory. The study also explored that changing the mode of communication from Line to Google Docs chat-room appears to have led to an increase in the participants' interaction and communication and seems to have facilitated collaboration. Therefore, to complete digital tasks, instructors should understand participants' perceptions of using multiple modes and carefully select them according to the task purpose and learners' language proficiency. Meanwhile, instructors should provide guidelines for integrating technology in instruction to set learning goals for students, use strategies and digital skills to complete the tasks, and provide students with linguistic and rhetorical practice.

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