Analyzing Collaborative Note-taking Behaviors and Their Relationship with Student Learning through the Collaborative Encoding-Storage Paradigm

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Abstract

Note-taking is a ubiquitous learning strategy that learners employ when attempting to comprehend and remember information shared during lectures. However, the process of note-taking can be cognitively burdensome for learners. Research has shown a number of benefits to collaborative note-taking, including a reduction in the cognitive burden required to take notes, the creation of more comprehensive notes than those typically produced by an individual, and exposure to the varying perspectives from peers. However, research is needed into the effects of various types of collaborative note-taking behaviors on the quality of the notes and on subsequent learning outcomes.

Therefore, the present research investigates the effects of collaborative note-taking behaviors of 357 students. To better conceptualize note-taking behaviors and their effects, the present dissertation introduces a theoretical framework called the collaborative encoding-storage paradigm, which extends the existing encoding-storage paradigm commonly used to explain individual note-taking behaviors. In the proposed framework, collaborative note-taking behaviors are viewed as forms of collaborative encoding and the completeness of the notes is viewed as a measure of storage quality. The following collaborative note-taking data were mined from the notes and analyzed: volume of words written, edits of others, writing sessions, and turn-taking. The storage produced by each group was assessed using a rubric to measure the completeness of the notes. Analysis at the level of the individual learner indicated that volume of words, edits of others, and turn-taking behaviors were all positively correlated with learning performance. Analysis at the level of the group indicated that turn-taking was positively correlated with learning

performance, while edits of others was negatively correlated with learning performance. Further analysis at the group level revealed that volume of words and frequency of writing sessions were positively correlated with the completeness of group notes and that completeness of notes was positively correlated with learning performance.

Overall, the results demonstrate meaningful relationships between the frequency of collaborative encoding behaviors and learning outcomes. These results suggest that collaborative encoding and storage have different effects on learning performance and that the effectiveness of collaboration differs according to the variables investigated and the level of analysis. The dissertation concludes with two recommendations for practitioners: 1) to increase recall of information, encouraging students to write more notes is beneficial, but encouraging them to write more frequently is not, and 2) for groups to take higher quality notes, they should be encouraged sustain their contributions to the document but need not interact much with the contributions of their group mates.

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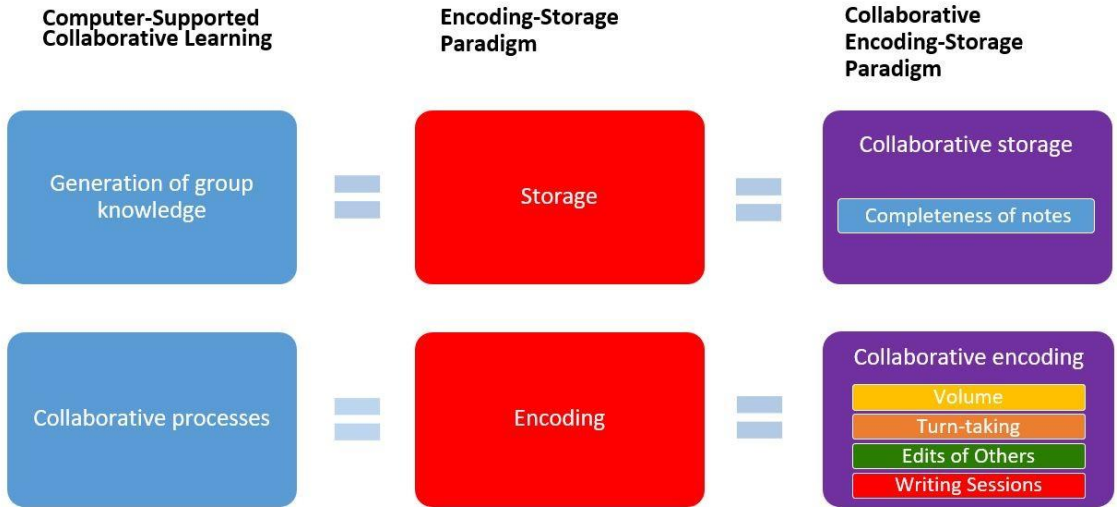

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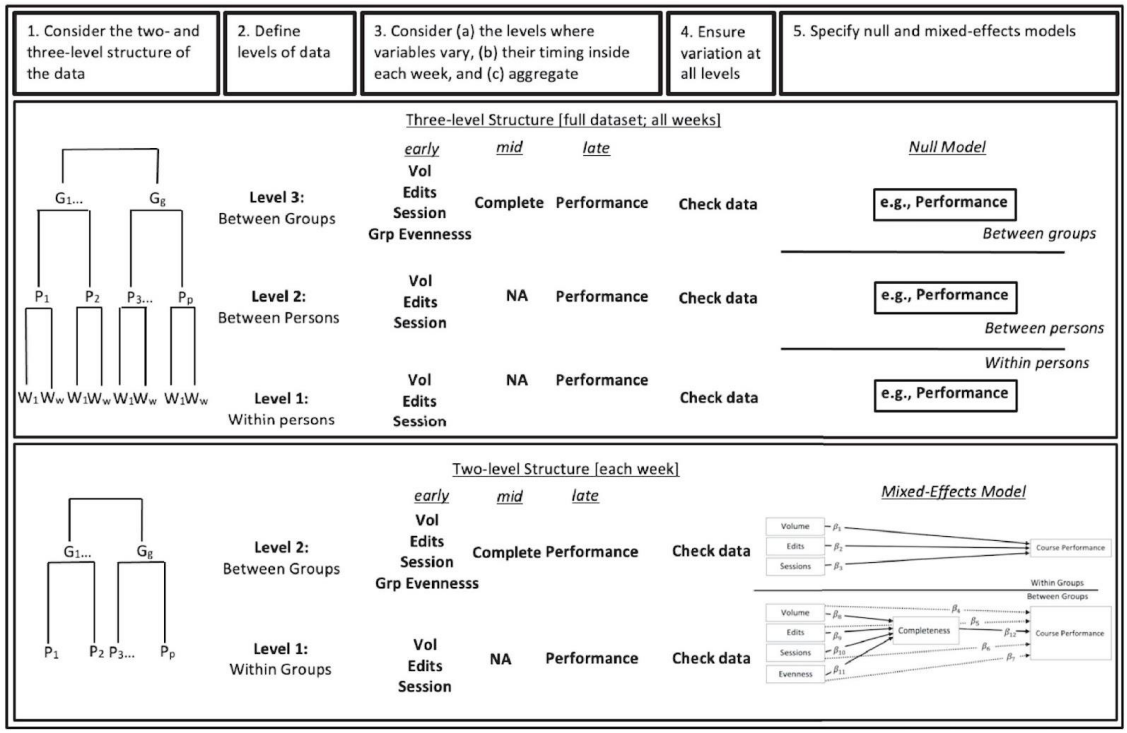

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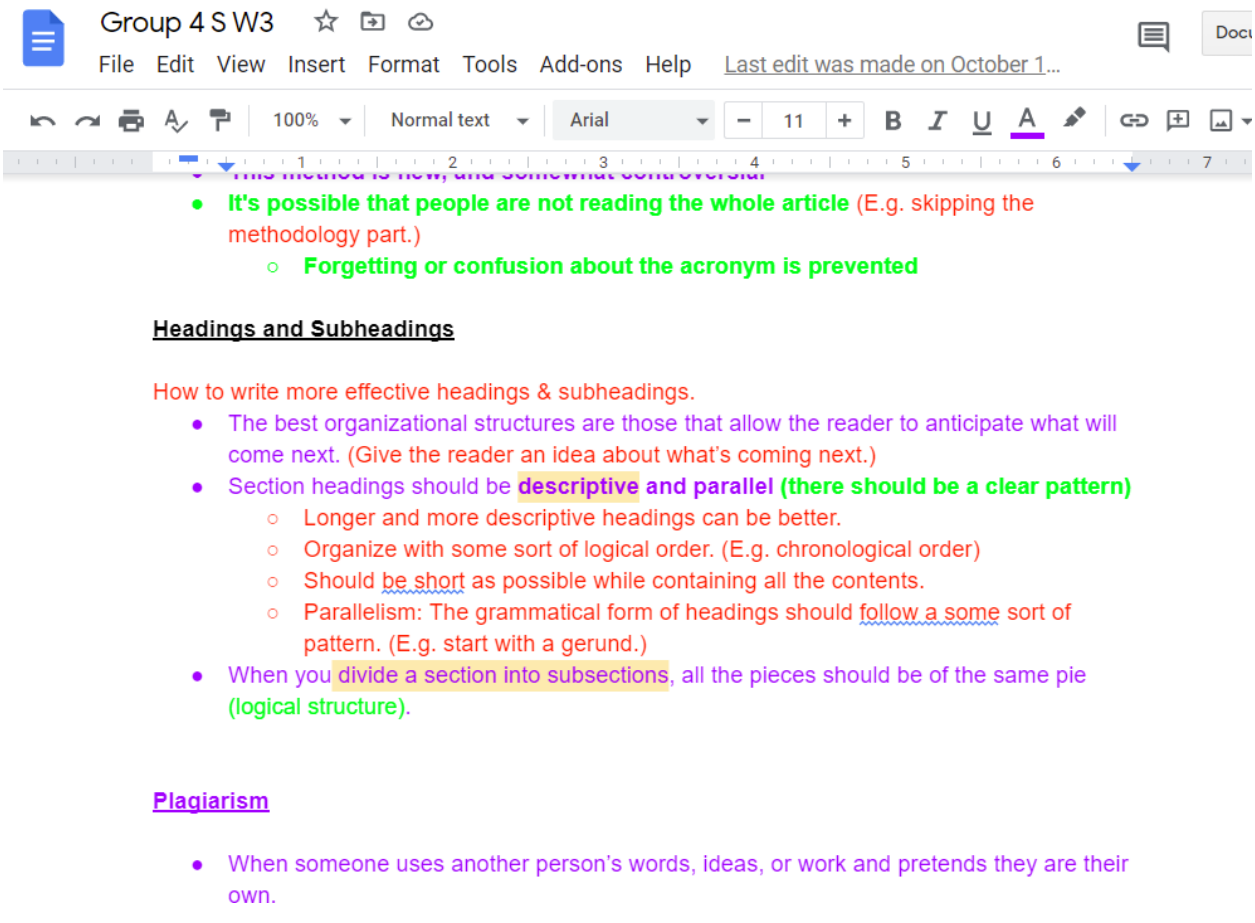

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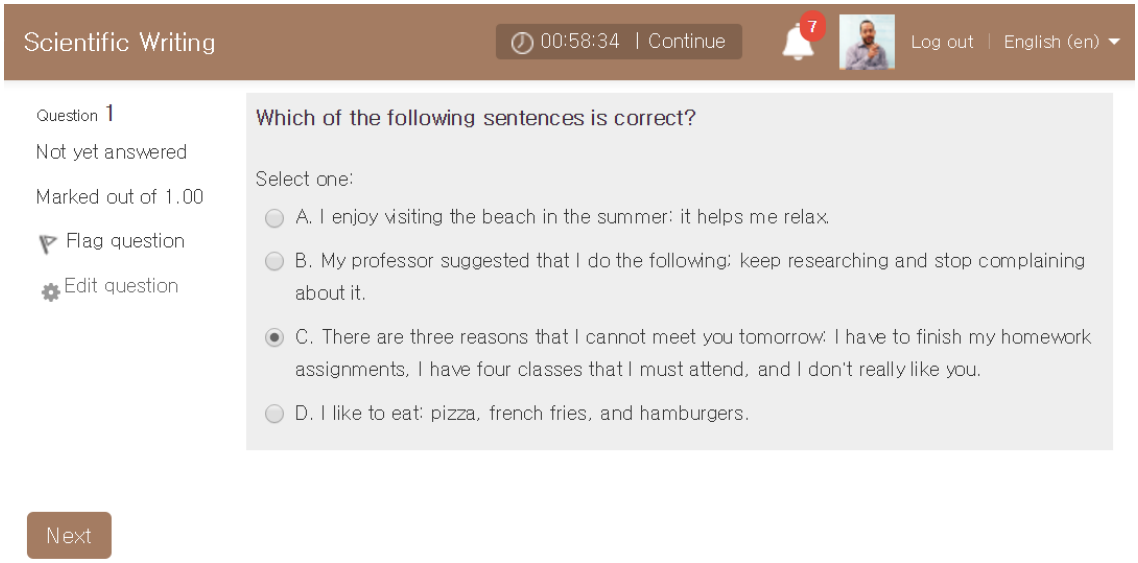

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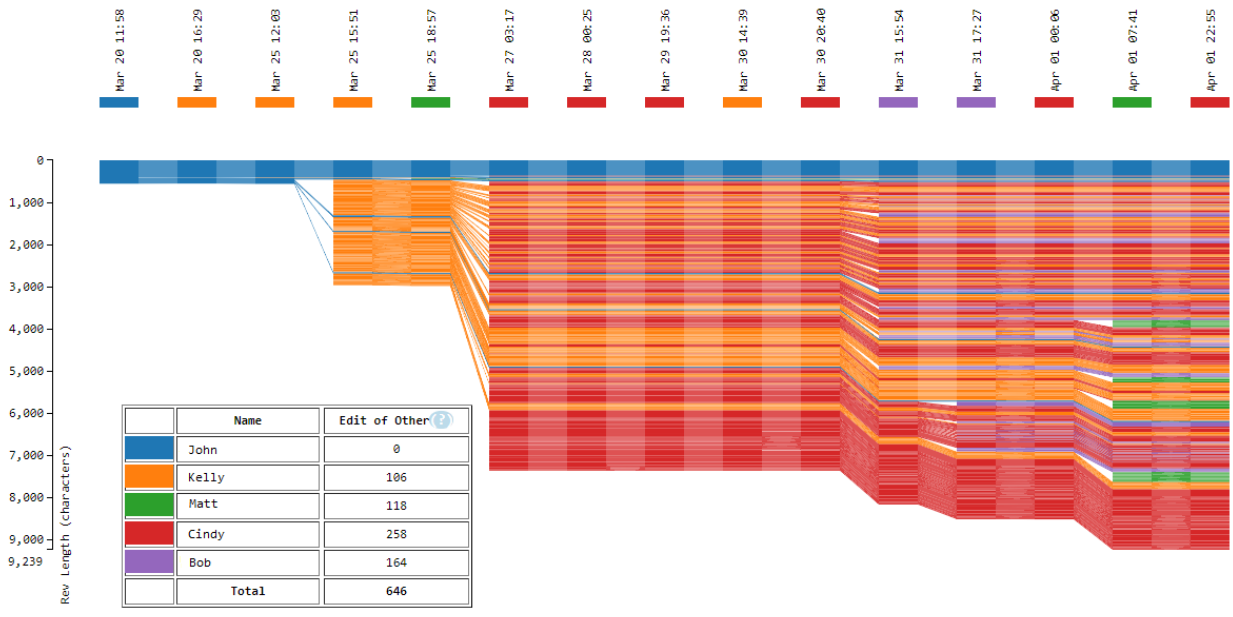

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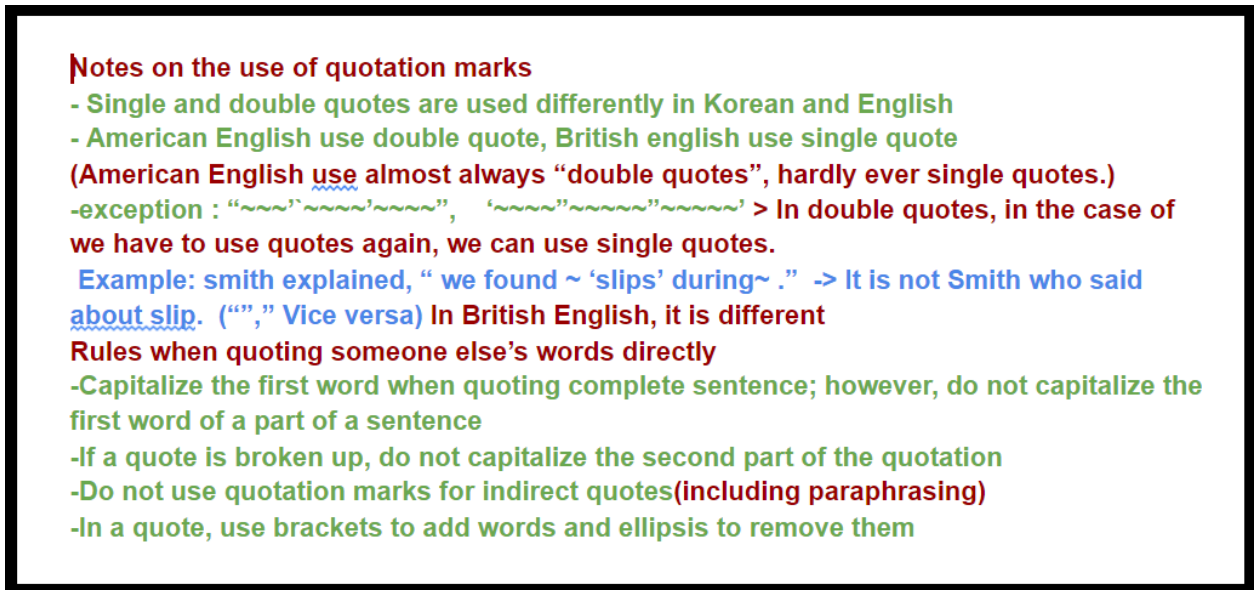

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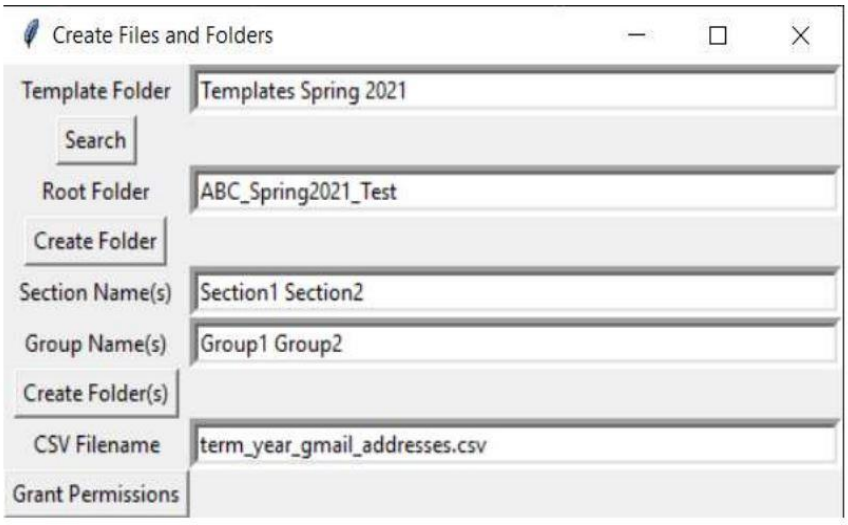

Table 3.1

Weekly Learning Content and Activities in the Scientific Writing Course

Week	Topic	Video #	Note #	Quiz #	In-class activity	Assignment
0	Course Orientation	NA	NA	Pre-test	Pre-test	Topic Proposal
1	Introduction	1 – 8	1	1	Group writing activity: Introduction	1st draft of Introduction
2		9 – 13	2	2	Peer editing Introduction	Final draft of Introduction
3	Methodology	14 – 17	3	3	Group writing activity: Methodology	1st draft of Methodology
4		18 – 19	4	4	Peer editing Methodology	Final draft of Methodology
5	Results	20 – 23	5	5	Group writing activity: Results	1st draft of Results
6		24 – 28	6	6	Peer editing Results	Final draft of Results
7	Discussion & Conclusion	29 to 32	7	7	Group writing activity: Discussion & Conclusion	1st draft of Discussion & Conclusion
8		33 – 36	8	8	Peer editing Discussion & Conclusion	Final draft of Discussion & Conclusion
9	Abstract, Title, and References	37 – 44	9	9	Group writing activity: Abstract	1st draft of Abstract, Title, and References
10		45 – 50	10	10	Peer editing Abstract, Title, and References	Final draft of Abstract, Title, and References

Note. A numbered list of online lecture video topics can be found in Appendix One.

Table 3.2

The Demographic Variables for the Participants (n=357)

Gender	**Male**	**Female**		
	261	96		
Nationality	**Korean**	**Foreign**		
	293	64		
Degree	**Masters**	**Ph.D.**		
	268	89		
Age	**Min**	**Max**	**Avg**	**SD**
	20	55	26.97	4.55

Table 4.1

Descriptive Statistics for Measures of Collaborative Note-taking (n=357)

Variable	*M*	*SD*	Min	Max	Descriptor
Volume[1]	257.75	106.99	54	775	Total words contributed by each individual member per week
Writing Sessions[1]	1.84	1.25	0	12	Total number of writing sessions taken per group per week
Turn-taking[1]	7.04	7.47	0	53.75	The number of times the author changed within the document per group per week
Edits of Others[1]	461.08	1140.47	0	2,394	The amount of keystrokes students make over another's writing per individual member per week
Completeness of notes[2]	77.21	54.73	19	252	Total concepts represented per group per week
Quiz Scores[1]	2.07	0.54	0	3	Mean quiz score per group per week

Note. Descriptive statistics given for all possible values across all weeks (grand means); [1]values in variable vary each week individually; [2]value in variable varies each week by group only.

Table 4.2

Intraclass Correlation Coefficients for Collaborative Note-Taking Variables

ICC	Completeness of notes	Quiz Scores	Volume	Sessions	Turn-taking	Edit of Other
Between Groups	0.023	0.079	0.044	0.073	0.401	0.030
Between Persons		0.159	0.278	0.249	0.131	0.153
Note. ICC = intraclass correlation.						

Table 4.3

Between Persons Correlation Matrix

Variable	Completeness of notes	Quiz Scores	Volume	Edits of Others	Sessions	Turn-taking
Completeness of notes						
Quiz Scores		1				
Volume		**0.075*** **	1			
Edits of Others		**0.028***	**0.088*** **	1		
Sessions		0.032	**0.087*** **	0.005	1	
Turn-taking		**0.047*** **	**0.143*** **	**0.028***	**0.034***	1
Note. *$p < .05$, **$p < .01$, ***$p < .001$						

Table 4.4

Between Groups Correlation Matrix

Variable	Completeness of notes	Quiz Scores	Volume	Edits of Others	Sessions	Turn-taking
Completeness of notes	1					
Quiz Scores	**0.018****	1				
Volume	**0.023*****	0.007	1			
Edits of Others	0.009	**-0.033***	0.013	1		
Sessions	**0.016***	0.018	0.023	0.000	1	
Turn-taking	0.021	**0.073***	0.038	-0.016	0.048	1

Note. *$p < .05$, **$p < .01$, ***$p < .001$.

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I would like to acknowledge everyone who has contributed to this dissertation project. First, I sincerely thank my supervisor, Kyungmee Lee, for her guidance during my studies. In my supervisor, I have found a friend and collaborator with whom I intend to continue coauthoring for the rest of my career. I would also like to thank my friend and coauthor, Jamie Costley, for his invaluable contributions to the present study, for introducing me to the field of educational technology, and for encouraging me to enroll in a PhD program several years ago. I would also like to acknowledge Matthew Baldwin, Matthew Courtney, and Jim Chang. Your contributions to the project were integral, and it is always a pleasure to conduct research with each of you. I also wish to thank my teaching assistants, particularly Jae Young Yoo and Marcel Beha, for all their assistance with my Scientific Writing course, and by extension, the research that I conducted. I would also like to express my gratitude to my viva committee members, Curtis Bonk and Murat Öztok, for their valuable insights and suggestions. Lastly, I wish to express my deepest gratitude to my wife Raisa Kharbash for her endless support during this degree process. I dedicate this dissertation to our lovely daughters, Mia and Karina, for whom I hope this dissertation will serve as a reminder that education is valuable and takes a lifetime.

Author's declaration: I declare that this dissertation is my own work and has not been submitted in substantially the same form for the award of a higher degree elsewhere.

Publications from the Dissertation Project

* denotes corresponding author

Fanguy, M., Costley, J.*, Courtney, M., & Lee, K. (Under review). Analyzing Collaborative Note-taking Behaviors and Their Relationship with Student Learning through the Collaborative Encoding-Storage Paradigm.

Courtney, M., Costley, J., Baldwin, M., Lee, K., & Fanguy, M*. (2022). Individual versus collaborative note-taking: Results of a quasi-experimental study on student note completeness, test performance, and academic writing. *The Internet and Higher Education, 55*, 100873. https://doi.org/10.1016/j.iheduc.2022.100873

Costley, J., Courtney, M., & Fanguy, M.* (2022). The role of collaborative note-taking behaviors, note completeness, and course performance: Examining multi-level temporal effects for a 10-week student writing program. *The Internet and Higher Education, 52*, 100831. https://doi.org/10.1016/j.iheduc.2021.100831

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Fanguy, M., Baldwin, M., Shmeleva, E., Lee, K., & Costley, J.* (2021). How collaboration influences the effect of note-taking on recall of contents and writing performance. *Interactive Learning Environments*. https://doi.org/10.1080/10494820.2021.1950772

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Fanguy, M.,* & Chang, J. (2021). Operationally Defining Turn-taking in Collaborative Online Documents. In Hmelo-Silver, C. E., De Wever, B., & Oshima, J. (Eds.), *Proceedings of the 14th International Conference on Computer-Supported Collaborative Learning* - CSCL 2021 (pp. 173-176). Bochum, Germany: International Society of the Learning Sciences. https://doi.dx.org/10.22318/cscl2021.173

Chang, J., & Fanguy, M.*. (2021). Collab_doc_maker: A Google-Doc-making tool. In *Proceedings of the International Conference on Computer Science and Education 2021*. (pp. 806-809). Institute of Electrical and Electronic Engineers (IEEE). http://doi.org/10.1109/ICCSE51940.2021.9569570

Chapter 1: Introduction

1.1 Research Background

Educational technologies that enable online learning present important opportunities and challenges for instructors and students, and such technologies are disrupting the manner in which instruction is given and received, as well as the ways in which students interact with one another (Liang & Chen, 2012). Since antiquity, instructors have disseminated information via lectures to learners who recorded their contents in the form of written notes (Rabinow, 1984), and these familiar practices remain in place in online learning environments today. However, modern online learning environments provide students with the following capabilities that can affect how they take lecture notes: 1) controlling the flow of information during a lecture, 2) increasing the speed of their note-taking, and 3) collaborating with classmates. As many online courses include pre-recorded lecture videos as an instructional component, students are able to exert some measures of control over the pacing of instruction by engaging in lecture viewing strategies such as pausing a lecture video, rewinding it, rewatching it, or skipping ahead (Fanguy et al., 2018). Such learner-controlled pacing of the contents may help to mitigate the substantial cognitive burden placed on students when trying to simultaneously listen, understand, and take notes during a lecture (Balfour, 2006; Davis et al., 2009; Marchand et al., 2014). The manner in which notes are taken has also changed with the rapid proliferation of wireless internet and portable electronic devices, enabling students to type their notes instead of handwriting them (Roberts & Rees, 2014). In online settings, as students log in to courses remotely using their personal computers, the often more expedient option of typing notes is now readily available to them (Weaver & Nilson, 2005). Lastly, advances in cloud computing technology have challenged traditional views on note-taking as a solitary practice by enabling multiple students to construct notes collaboratively in a shared online document using Google Docs or Microsoft Office Live. Collaborative note-taking, as with other forms of collaborative writing, implies that multiple group members will make decisions

about how group work will proceed and will contribute writing to the final product. When constructing notes collaboratively, students may relieve the considerable cognitive strain of attempting to read, listen, and write all at once by dividing up the task of note-taking among several learners (Orndorff, 2015). Furthermore, this type of collaboration exposes students to a variety of viewpoints and perspectives, which can improve their understanding of the course content, enabling them to make deeper connections with the material (Kirschner et al., 2018). Such opportunities for students to collaborate and connect with classmates are especially valuable in online remote learning contexts, where students have often reported feelings of isolation and disconnection from their peers (McInnerney & Roberts, 2004).

1.2 Statement of the Research Problem

Note-taking is a widely acknowledged strategy students employ to increase the depth of their ability to process (Bretzing & Kulhavy, 1979) and recall information from course lectures (Aiken et al., 1975; Oefinger & Peverly, 2020; Tindale et al., 2008). Nearly all university students take notes during lectures (Bonner & Holliday, 2006; Castelló & Monereo, 2005), and research has shown that taking notes is beneficial to their learning performance (Peverly et al. 2014). In the literature, note-taking has generally been viewed as an individual process by which a learner writes down concepts from a lecture in an attempt to move information from the working memory to the long-term memory. This cognitivist conceptualization of note-taking is often framed within a theoretical perspective known as the encoding-storage paradigm (Di Vesta & Gray, 1972). Within this paradigm, *encoding* refers to a learner writing down information in an attempt to imprint it onto the long-term memory (Peper & Mayer, 1978). The written record of relevant information that is produced as a result of such encoding is referred to as *storage* (Di Vesta & Gray, 1972), which can be reviewed later so that the learner need not attempt to recall every point mentioned in the lecture (Mueller & Oppenheimer, 2014). Therefore, while encoding provides a direct benefit to the learner in terms of facilitating the migration of information from the working memory to the long-term memory, encoding also has the indirect benefit of providing the learner with storage, i.e.,

written records of the learning content that can be accessed later (Di Vesta & Gray, 1972). Storage can provide a useful supplement to the imperfect long-term memory when reviewing notes, particularly when preparing for a test or exam (Kiewra, 1989).

While most of the research on note-taking examines contexts where notes are taken by a single learner, recent advances in cloud computing enable multiple students to take notes together in a shared online document. Research on online collaborative note-taking is still in its infancy, although a number of studies have shown benefits to this practice, including higher grades (Orndorff, 2015) and improved recall (Fanguy, Baldwin, Shmeleva et al., 2021). Although the cognitivist viewpoint that underpins the encoding-storage paradigm offers a useful explanation of the mechanisms by which individuals process and store information when writing notes collaboratively, none of the studies on online collaborative note-taking have examined the effects of such learning activities through the encoding-storage paradigm. This may be because the encoding-storage paradigm is deemed insufficient to account for the complex relationships and social interactions among group members in constructing notes.

Instead, research has largely viewed online collaborative note-taking like any other form of online collaborative writing, often from the social constructivist perspective of computer-supported collaborative learning (CSCL), where learning is understood as a process of interaction among learners using technology (Stahl et al., 2006). CSCL research suggests that students who collaborate using technology learn by 1) engaging in collaborative processes that lead them to deeper, more meaningful comprehension of the topics being studied (Stahl et al., 2006) and 2) co-constructing new knowledge through this interaction, often in the form of a knowledge artifact as the group product (Stahl et al., 2014). While these drivers of collaborative learning provide a useful way to conceptualize the complex interactions and relationships among the behaviors of the group members and the notes they create, they do not provide insight into the mechanisms by which concepts represented in the notes enter the long-term memories of the individual members, which is an important

contribution of the encoding-storage paradigm and a key issue with respect to note-taking.

Moreover, prior research on collaborative note-taking has largely focused on the effects of collaborative note-taking on subsequent learning outcomes (Baldwin et al., 2019; Orndorff, 2015; Costley & Fanguy, 2021). What is missing from the literature is a systematic analysis of collaborative behaviors and strategies that learners engage in as well as the digital artifact that students create when taking notes collaboratively. Such analysis could help to answer two important questions: 1) *What collaborative behaviors are most beneficial to learning performance when taking notes?* and 2) *What do effective collaborative notes look like?* In other words, prior research has focused on the question of *whether* collaborative note-taking is beneficial to learning performance, but now research is needed to understand *how* it can be beneficial.

1.3 Research Aims

The aims of this study are to analyze how encoding affects storage, how encoding affects learning performance, and how storage affects learning performance in the context of collaborative note-taking. Increased understanding of these aspects of collaborative note-taking can support successful implementation of this strategy in a variety of learning contexts. Therefore, the present study has the following six objectives.

1. Introduce a new conceptual framework with which to interpret the collaborative behaviors students engage in when taking notes and the digital artifact that they produce.
2. Investigate the collaborative behaviors that individuals and groups engage in when taking notes collaboratively to better understand how these affect learning outcomes.
3. Examine the collaborative behaviors that individuals and groups engage in when taking notes collaboratively to better understand how these affect the quality of notes groups take.

4. Analyze the quality of the notes that groups take to better understand how this affects learning performance.
5. Develop software tools that practitioners and researchers can use to implement and analyze collaborative note-taking.
6. Provide recommendations to practitioners and researchers about how to implement successful note-taking interventions in their own courses.

1.4 Description of the Present Study

The purpose of the present study was to analyze how encoding affects storage, how encoding affects learning performance, and how storage affects learning performance in the context of collaborative note-taking. While both the encoding-storage paradigm and the CSCL perspective of online collaborative note-taking help to explain the benefits of this learning strategy, each has an important limitation. The encoding-storage paradigm is the predominant theoretical perspective on note-taking research because it provides an explanation of how note-taking improves recall of course contents; however, as currently constructed, it is unable to account for the complex ways in which group members collaborate in creating and learning from notes. On the other hand, the CSCL perspective provides a useful way to analyze collaborative behaviors students engage in and the digital artifact they produce in order to examine how online collaborative note-taking can benefit student learning outcomes. However, it lacks an explanation of the mechanisms by which students are able to improve their recall of course contents.

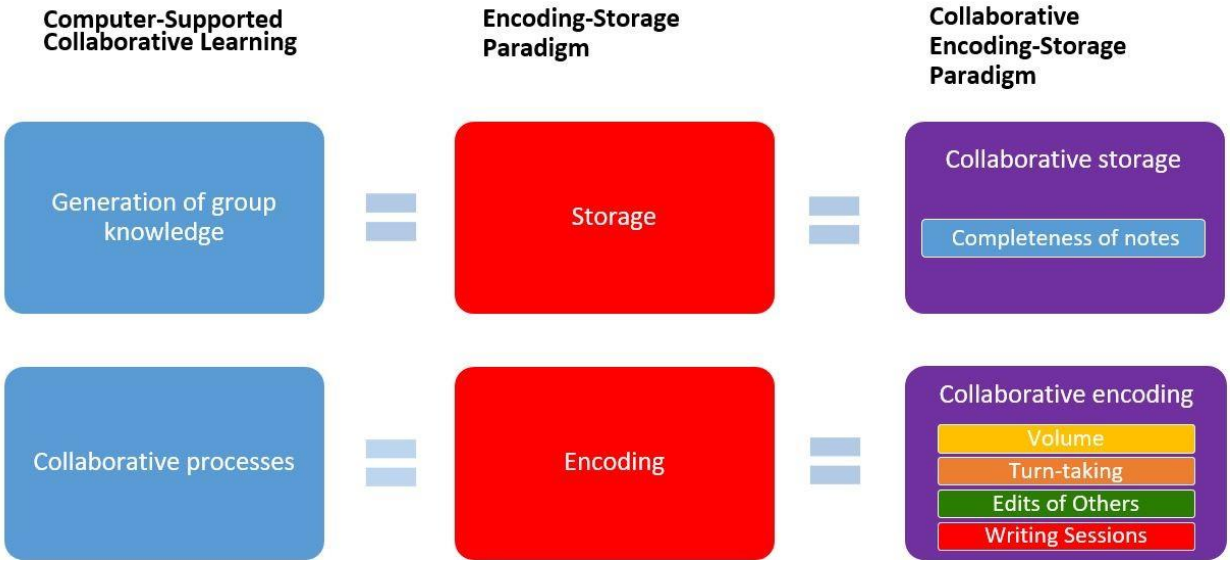
Therefore, the present study seeks to incorporate aspects of both the encoding-storage paradigm and CSCL when examining the effects of collaborative note-taking. From this new theoretical perspective, the present study aims to analyze the effects of collaborative note-taking on subsequent learning performance at both the level of the individual and of the group. A limitation of extant research on collaborative note-taking is that the two aforementioned drivers of the benefits of collaborative learning (i.e., individual collaborative behaviors and creation of group knowledge) are often looked at together so that it is difficult to understand them as separate aspects of learner

collaboration. The present study seeks to separate the two aforementioned aspects of collaborative learning in the context of note-taking (herein, collaborative encoding and collaborative storage) in order to better understand the effects of each on learning performance.

The proposed collaborative encoding-storage paradigm, which will serve as the theoretical framework for the present study, is visualized in Figure 1.1. Within this framework, storage will represent the creation of knowledge by the group and will be measured by evaluating the completeness of the notes that the group produces, i.e., how many concepts from the lecture are represented in the notes. Completeness is a conventional measure of storage in note-taking studies and is generally viewed at the level of the individual, i.e., the number of concepts from a lecture that a single learner writes down in the notes. However, this study will view storage as a group-level measure of the total amount of information recorded in the notes that the group members create and share. In the traditional encoding-storage paradigm, encoding is also viewed at the level of the individual, and prior measures of encoding generally analyze how many notes a learner records and how much content can be recalled on a subsequent exam (Di Vesta & Gray, 1972; Kiewra, 1989; Mueller & Oppenheimer, 2014). However, when learners take notes collaboratively, there are many more writing (and therefore encoding) behaviors that they can engage in because group members may respond to and interact with one another's contributions. Therefore, the proposed encoding-storage paradigm views productive aspects of contribution to the collaborative notes as "collaborative encoding" that can be measured at both the individual and group levels. Specifically, the following collaborative writing behaviors will be considered as encoding variables: the amount of writing students contribute, the number of times they login to the document to contribute notes, the number of turns they take during the writing process, and the number of edits they make to the writing of other group members.

Figure 1.1

The Collaborative Encoding-storage Paradigm



1.5 Positionality and Prior Research Experience on This Topic

I taught my first university writing course in 2001 at the Korea Advanced Institute of Science and Technology in Daejeon, South Korea, shortly after completing my master's degree in English and Linguistics, with a specialty in Rhetoric and Composition. While my degree helped me to develop a theoretical understanding of how people learn to write, at times I found it difficult to apply this theory in designing courses that would be appropriate for my students' needs and goals. The culmination of this feeling coincided with an important event that awakened my curiosity and began my journey as a researcher. The president of my university introduced a university-wide goal of converting 30% of existing courses into flipped format. This was done in an attempt to harness the power of educational technology to create more engaging, accessible, and effective instruction for students. In 2013, I joined this initiative and created a flipped version of the Scientific Writing course I had previously been teaching entirely offline. This transition required me to completely rethink the design, instructional delivery, and the sequencing of the learning content of the course. Entering the world of technology-enhanced learning (TEL) presented

opportunities to rethink many assumptions and caused me to ask some fundamental questions about curriculum instruction and design with regard to TEL. *What role should collaboration play in learning in online environments? How does collaboration affect student learning at different levels of skill and knowledge?*

In examining the research literature on such questions, I realized that there were few clear answers and that many researchers shared my curiosity regarding such questions. I began to see that I had an opportunity to employ new approaches in my classes and potentially help to shed light on key questions in the fields of instructional design and TEL. I began to look for ways to change my courses in order to improve students' learning experiences and outcomes. While continuing my reading in the fields of instructional design and TEL, I began more carefully considering responses to student evaluations, conducting student interviews, and examining students' performance on course assignments in my class. Each research article I read led me to new questions, inspiring me to make new attempts to bridge the gap between theoretical knowledge and instructional practice by implementing new modes of instruction based on what I was learning. As a course designer and instructor, I became an incessant tinkerer, constantly making small adjustments in my course each semester to see what effects could be achieved. These research questions and changes to my courses became more systematic over time, eventually yielding results that I began to publish in academic journals.

One day back in 2017, while attending a seminar in the School of Computing at KAIST, I noticed a group of students sitting together, each typing notes into his/her own laptop. Some of the students in the group had taken my Scientific Writing course, so after the seminar, I talked to them about what they were typing. To my surprise, they were all contributing to a single Google Doc, creating a shared set of notes. After the seminar, I talked to the students about their strategy, and I was impressed by their rationale: the students felt that they could share their insights with one another and reduce the stress and burden of trying to write down notes as they listened. I began to consider how collaborative note-taking could be used in my own Scientific Writing class at

KAIST. Would this type of note-taking also have value in an asynchronous instructional context, where prerecorded online videos are used?

Initially, I decided to set up collaborative note-taking as an instructional strategy in my course in order to see how it affected students' learning outcomes. I asked one of my coworkers who also taught Scientific Writing to help me run an experimental study to test the effectiveness of collaborative note-taking. We conducted a study (Baldwin et al., 2019) with a control group and a treatment group, who were asked to create Google Docs and share them with small note-taking groups of 4-5 students. Quiz and writing assignment scores were used as the dependent variables in the study to test the effect of each note-taking condition. Unfortunately, this study was largely unsuccessful because members of the collaborative note-taking group produced very few notes, and the notes that were produced were generally dominated by one or two group members. As a result, no differences were found in the learning outcomes of the two groups. However, the students who provided the lion's share of contributions within the collaborative note-taking condition did perform better on learning assessments than other students, indicating that there might indeed be some value to collaborative note-taking as a learning strategy. Further investigation was needed.

In the Spring semester of 2020, this concept of collaboration became even more important in my class, as the COVID-19 pandemic caused all courses to be migrated to fully online format. This presented an important change to my style of instruction, which was formerly given in flipped format. Now, the face-to-face course meetings were to be given via live teleconferencing on Zoom. I worried about the potential reduction in social interaction between myself and my students, as well as the social interaction they would lose with one another. I felt that increasing students' ability to interact with one another outside of the classroom would be one way of addressing this concern. Online collaborative note-taking presented a fantastic opportunity to do that.

Once again, my co-authors and I decided to conduct a study on the effects of collaborative note-taking, but this time, the research would be conducted much more systematically. In order to compare the effectiveness of collaborative note-taking with individual note-taking, we created two treatment groups. In the individual note-taking condition, I created Google Docs for each of 10 instructional weeks of the course per individual. Then, students in the collaborative note-taking condition were asked to make groups of 4-5 students, and I created Google Docs for each of 10 instructional weeks of the course per group. In total, I created nearly 1,000 Google Docs for the experiment using custom software that a coauthor and I developed (Chang & Fanguy, 2021). Creating the Google Docs myself saved my students some effort, ensured uniformity within the experimental set-up, and allowed me to have full and permanent access to the documents so that I could check on student participation, assess the quality of the notes, and analyze the writing behaviors of the groups.

The first study from this line of research (Fanguy, Baldwin, Shmeleva et al., 2021) showed that collaborative note-takers produced significantly more complete notes than individual note-takers, but that individual note-takers wrote a significantly higher number of words than did members of collaborative note-taking groups. Collaborative note-takers significantly outperformed individual note-takers on quizzes, but individual note-takers earned significantly higher scores on writing assignments than did collaborative note-takers. The higher quiz scores of the collaborative note-taking group corresponded to my initial hypothesis since I expected collaborative note-takers to experience a reduction in the cognitive resources required to take notes during a lecture, since this task was shared with others. However, the higher writing scores of the individual note-takers were unexpected, and I surmised that they may have occurred as a result of increased writing practice afforded to individual note-takers as compared to collaborative note-takers. Specifically, individual note-takers wrote down around 6,000 more words on average during the course, which is a substantial amount of extra writing practice. In a subsequent study (Courtney, Costley, Baldwin, Lee, & Fanguy, 2022), we found that this effect seemed to

grow stronger week-by-week during the semester, as would be expected if practice were the cause for the higher writing scores among individual note-takers as compared to those in the collaborative condition. These results further highlight that collaborative note-taking has value as a learning strategy, though the application and use of collaborative note-taking should be carefully considered depending on the goals of the course, e.g., collaborative note-taking does not seem to be an optimal learning strategy when the goal is to enhance writing scores. However, when the goal is to help students comprehend and recall course content, which is a common goal in many courses, collaborative note-taking shows promise.

My focus now and in the present dissertation has shifted from *whether* collaborative note-taking is effective to *why* and *how* it may be effective. In other words, I am no longer comparing the effectiveness of collaborative note-taking to that of individual note-taking. Instead, I am now trying to better understand how and why collaborative note-taking confers benefits on student learning performance on quizzes. To do this, I analyze the processes and behaviors learners engage in when constructing collaborative notes by mining learning data such as the volume of words contributed, the number of writing sessions that they engage in, the number of turns they take when contributing notes, and the number of edits students make to the writing of their group mates. Statistical analyses can then be performed to better understand the effects of collaborative behaviors on the quality of the notes that are produced and on the scores learners receive on subsequent quizzes. The present study helps to fill an important gap in the literature since extant research has largely ignored the quality of notes produced by collaborative groups as well as the collaborative behaviors and processes learners' use when constructing them. The present research seeks to better understand the effects of collaboration on note-taking and learning in order to provide insight into and recommendations on how to improve the effectiveness of this promising learning strategy.

1.6 Contribution

The present study provides a number of important contributions to the field of educational research and to the classroom as well. I will explain each of these below.

1.6.1 Knowledge contribution

Research on collaborative note-taking is still in its infancy, as shared online documents have only been widely available to the public since 2009. Although there have been only a small number of studies on this topic, nearly all have shown important benefits to collaborative note-taking, including higher grades (Orndorff, 2015) and a more inclusive and equitable learning environment (Harbin, 2020). However, there has never been a rigorous attempt to explain how and why these benefits occur, as researchers have generally relied on self-reported data from student surveys or speculation to explain their results. The present study helps to fill this gap by systematically examining the collaborative behaviors and processes that learners engage in when taking notes in groups, as well as the quality of the notes that students produce when collaborating.

1.6.2 Theoretical contribution

Most research on note-taking in the literature has focused on the cognitive processes a learner engages in when taking notes as a solo endeavor. The most widely used theoretical framework in such studies is the encoding-storage paradigm proposed by Di Vesta and Gray (1972). The encoding-storage paradigm has been used pervasively in note-taking research because it offers an explanation of the mechanisms by which note-taking may enhance learning and memory of lecture contents. However, thus far, no study in the literature has attempted to apply this framework to collaborative note-taking, perhaps because researchers find that it is limiting when trying to explain or account for the effects of social processes learners engage in when collaborating. Instead, researchers have treated online collaborative note-taking like any other form of online writing, viewing it through the social constructivist lens of Computer Supported Collaborative Learning (CSCL). By approaching

collaborative note-taking from this CSCL viewpoint, researchers are able to account for the collaborative processes learners engage in when taking notes in groups. However, the CSCL viewpoint lacks explanatory power with regard to the mechanisms by which the note-taking process leads to enhanced learning performance.

The present study offers a new theoretical perspective that I believe is more suitable than either of the aforementioned frameworks for understanding collaborative note-taking: the collaborative encoding-storage paradigm. The proposed framework mends the encoding-storage paradigm with the CSCL perspective by viewing collaborative note-taking behaviors as methods of collaborative encoding, and these include the total contribution of words written (volume), number of writing sessions learners engage in (sessions), the number of times text is interleaved among group members (turn-taking), and the amount of edits made to the writing of other group members (edits of others). The collaborative encoding-storage paradigm views each of these collaborative encoding behaviors at the individual level and the group level, as these behaviors may have differing effects on an individual learner who performs them and on the group as a whole. Finally, the digital artifact that is produced by the group through collaborative encoding can be viewed as collaboratively generated knowledge and is called collaborative storage. To the best of my knowledge, the proposed framework represents the first attempt to interpret collaborative note-taking behaviors from the cognitive perspective of encoding-storage paradigm, the most common theoretical framework used in note-taking research. It is hoped that the proposed framework will be of use in much-needed future research analyzing how collaborative behaviors learners engage in when taking notes and the collaborative artifact they produce affect subsequent learning performance.

1.6.3 Pedagogical contribution

The first pedagogical contribution of the present study is that it provides important insights into ways in which note-taking can be enhanced as a learning strategy. Note-taking is a ubiquitous learning strategy, and there is a

large body of research demonstrating its efficacy in improving learning outcomes. However, an important problem with note-taking is that an extremely large amount of cognitive resources is needed when attempting to listen to, comprehend, and take notes on a lecture – enough to overwhelm a learner's working memory. Collaborative note-taking can help to mitigate this cognitive burden since learners in a group may share the labor of taking notes, potentially freeing up cognitive resources to make deeper connections among the lecture contents. Furthermore, as a group of students is more likely to produce more comprehensive notes than an individual student working alone, group members share an important benefit in the form of access to the digital artifact they produce. The results of the present study provide instructors and students with recommendations on how collaborative note-taking behaviors and the quality of the notes that are produced affect subsequent learning performance. Such recommendations can be used by practitioners to better understand how to successfully implement collaborative note-taking in their courses, and can help students to understand how their collaborative behaviors will affect their own learning experiences, as well as the experiences of their group mates.

The second pedagogical contribution of this study is that it provides recommendations to instructors and students on how to effectively engage in a social process of learning that can occur online at any time, including outside of scheduled class meetings. With the recent rise in online and blended learning, students have often reported a sense of isolation in these environments and a loss of social connectivity with their classmates in comparison to traditional face-to-face environments (Heo, Bonk, & Doo, 2022). During the migration to online education during the pandemic, instructors also frequently highlighted the difficulty of creating an adequate number of opportunities for learners to engage in active collaborative learning online (Lee et al., 2022). Collaborative note-taking as a practice provides a means for learners to engage with course content together asynchronously, which may help to alleviate some of the feelings of isolation they may experience in online learning environments. Moreover, with increased opportunities to collaboratively engage with course content online, learners can benefit from the insights and perspectives of their

peers, thereby enhancing their own understanding of the concepts being covered.

A third pedagogical contribution is that the practice of collaborative note-taking allows students to learn to communicate and negotiate with each other and to work together toward common goals. These “soft skills” are extremely important for all learners, and particularly those majoring in STEM (science, technology, engineering, and mathematics) fields, such as the participants in the present study. This is because research in STEM fields is often a collaborative endeavor involving groups of specialists who must learn to coordinate their efforts effectively in order to achieve their aims. The outcomes of such research are then collaboratively written up into manuscript form for publication in academic journals, and this collaborative writing process is increasingly occurring in online collaborative documents such as Google Docs, as authors may be geographically separated and in incompatible time zones. Therefore, the process of writing collaboratively online is, in and of itself, a highly valuable skill that STEM students may develop through the process of taking notes together online. These skills may prove useful to such students throughout their careers as researchers.

1.6.4 Technological contribution

The present study resulted in the creation of two customized computer systems that were respectively described in two papers published in the proceedings of computer science conferences. These two computer systems are provided as freeware to instructors in order to assist them in implementing collaborative note-taking in their own courses and to analyze the nature of the collaborative processes students engage in when constructing their notes.

The first computer system is called *Collab_doc_maker*, and it is used to automatically construct folders, subfolders, and Google Docs within Google Drive. Moreover, Collab_doc_maker can be used to automatically provide sharing permissions for these folders, subfolders, and documents to pre-assigned Google accounts. This computer system saved countless hours of

work in the present study by creating and sharing thousands of collaborative documents with student groups during the four semesters in which data was collected. The system enables instructors to relieve students of the burden of creating Google Docs when taking notes, providing uniformity and structure to the note-taking documents that students use. By freeing students from the burden of creating their own shared documents, Collab_doc_maker may help to reduce some of the extraneous cognitive cost associated with collaboration, allowing learners to focus their attention on course content. Moreover, when instructors create all the documents their students will use, it ensures that instructors will not lose access to these documents and will be able to monitor students' progress, settle disputes, and encourage balanced and active participation.

The second computer system, called *Collab_Notetaking*, was developed to automatically count the number of turns taken when writing a collaborative document within Google Docs. The paper that introduced the Collab_Notetaking computer system (Fanguy & Chang, 2021) contained the first attempt to define turn-taking within the context of collaborative writing. The study proposed that the number of turns in a collaborative document could be considered as the number of instances where co-authors interleaved their writing with the writing of others. Existing learning analytics tools for Google Docs do not provide data on turn-taking, which is considered to be an important aspect of collaboration, as it represents interactivity among collaborators when working together. Attempting to count turns by hand is an extremely burdensome task, especially when examining a large number of collaborative documents, as was the case in the present study. Collab_Notetaking provides this information automatically to researchers and practitioners who wish to examine the extent to which the collaborative writing process was interactive in a given assignment or task.

1.6.5 Methodological contribution

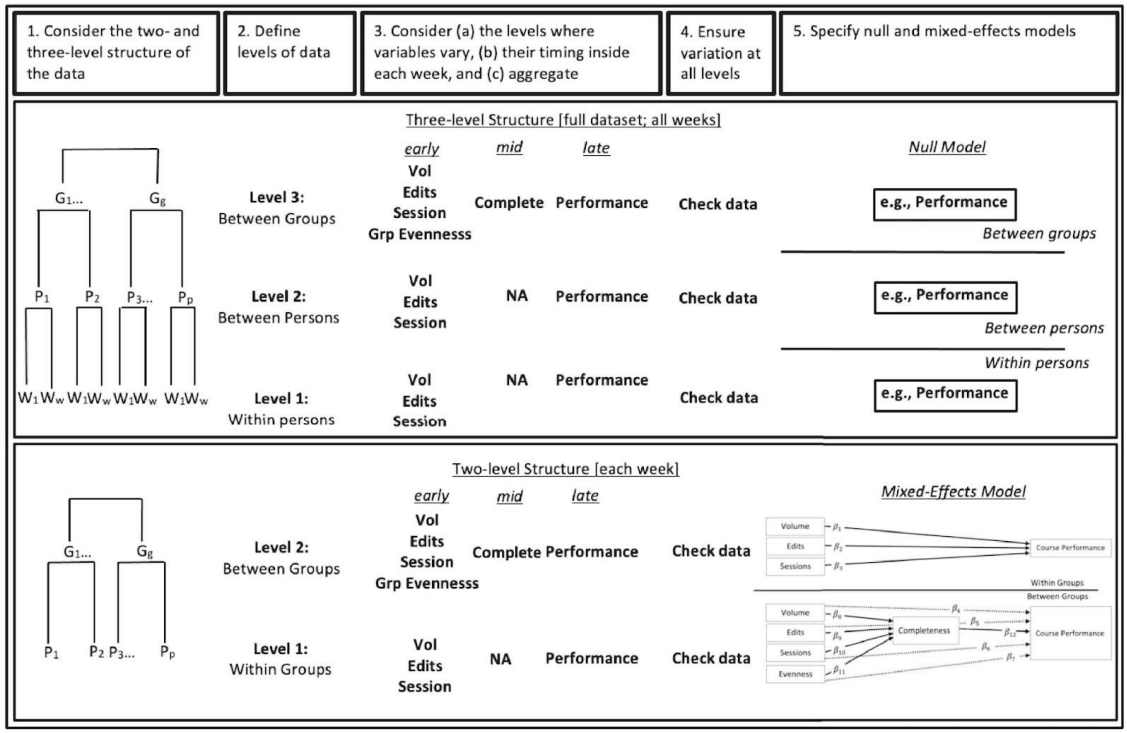
The present line of research necessitates multi-level analysis of collaborative writing behaviors. This is because the data produced in the study

is not independent and involves levels of nested hierarchies. For example, the volume of words produced each week is nested in and associated with each student, and the average volume of words across all weeks for each student is nested in and associated with each group (see Courtney, Costley, & Fanguy, 2022 for data description). Therefore, overall, individual student behavioral data in the current study can be conceived as existing at a between-groups level, a within-groups/between-persons level, and a within-person level.

The research contained in the present dissertation examines behaviors at the individual and group levels, more specifically from the within-group (or between-person) and between-group levels. Such examination is done as part of a novel five-step statistical method, which was developed for the present research project, called the Courtney-Fanguy-Costley (CFC) protocol (Courtney, Costley, & Fanguy, 2022), as shown in Figure 1.2 below. For the present dissertation research, a simplified version of this method was used for the within- and between-groups levels, involving only Steps 2 and 3 shown in the upper half of Figure 1.2. The CFC protocol provides a framework for statistical analysis that researchers can use when undertaking research projects with a similar design that analyze collaborative behavior and learning outcomes at various levels.

Figure 1.2

Courtney-Fanguy-Costley Five-step Protocol for Analyzing Repeated Measures of Online Group Behavior



Note. Dotted lines for mixed-effects model reflect supplementary regression coefficients to run in separate models.

1.7 Dissertation Structure

This dissertation comprises six chapters. Chapter 1 has provided background on the topic of the research and has stated the research problem and the significance of the research. The chapter has also provided a statement of my own positionality and prior research experience with this topic. Lastly, the chapter has described the aims of the study as well as its contributions in terms of knowledge, theory, pedagogy, technology, and methodology.

Chapter 2 presents a review of the literature of note-taking as a learning strategy, cognitivist conceptualizations of note-taking, associated technologies with note-taking, collaborative note-taking as a learning strategy, social constructivist conceptualizations of collaborative note-taking, and relevant

technologies related to collaborative note-taking. The chapter describes the extant research on the relationship between learning performance and each of the following collaborative note-taking behaviors: volume, writing sessions, turn-taking, and edits of others. The chapter goes on to describe the literature on the relationships between each of these collaborative behaviors and the quality of the digital artifacts that students produce when collaborating. The chapter further discusses the literature on the use of quizzes as a measure of learning performance. Finally, the chapter closes by identifying the gaps in the present body of research on note-taking generally and collaborative note-taking specifically.

Chapter 3 presents the research methods of the present study. The chapter begins with an overview of the methods used in the present study and the research questions that it seeks to address. The chapter goes on to describe the research paradigm that informs the research. Next, the quantitative data design is described in greater detail. After this, information is provided regarding the institutional and instructional context of the study. This is followed by a detailed description of the quantitative research design. Each of the quantitative variables is then described in terms of collection and analysis. The software tools that were developed and used in the present study are then presented. After this, the processes that were used to create the quantitative dataset and to conduct the quantitative statistical analysis are described in detail, followed by an explanation of the collection of qualitative data. The chapter concludes by presenting the ethical considerations of the study and the processes involved in gaining permission from the relevant institutions to conduct the research.

Chapter 4 provides the results of statistical testing of the data collected in the quantitative phase of the research (i.e., the collaborative encoding variables and quiz scores at the individual and group levels, as well as the completeness of the notes) in order to examine the effects of collaborative encoding on storage and on learning performance, as well as the effects of storage on learning performance.

Chapter 5 provides an in-depth discussion of the results from the quantitative phase of the study and uses relevant responses from the semi-structured interviews to provide context and complementary triangulation for these findings, relating the discussion to the collaborative encoding-storage paradigm, which is the theoretical framework of this dissertation research.

Chapter 6 reviews the major results for each of the four research questions that guide the study and outlines the knowledge, theoretical, pedagogical, methodological, and technological contributions of the study. The chapter then provides recommendations for practitioners based on the findings of the research, and concludes with limitations of the work and possibilities for future research.

Chapter 2: Literature Review

This chapter introduces the literature on note-taking generally, and collaborative note-taking specifically. To do this, the chapter begins with a general description of note-taking as a learning strategy, describing why notes are taken, and how they can benefit learning outcomes. Following this, the cognitivist perspective on note-taking is described, namely, the encoding-storage paradigm, which views the note-taking process as one in which students imprint information to their long-term memory by recording concepts through writing and by reviewing the learning artifact that they create. It is also important to consider the ways in which technology has affected such note-taking practices, so the chapter describes the role of computing devices in enabling students to type their notes and store them digitally, as well as how learning through online environments may affect the way that students take notes.

Such technologies have enabled students to collaboratively create their notes and share them with their peers, so the chapter continues with a discussion of collaborative note-taking as a learning strategy. To better understand how and why collaborative note-taking may foster learning, I have examined the social constructivist perspectives on collaborative note-taking, more specifically from the viewpoint of Computer-Supported Collaborative Learning (CSCL). As computer technologies enable and facilitate continuous and ubiquitous collaboration among collaborative note-takers, the chapter further explores collaborative note-taking and note-sharing tools that are used in online learning environments, as well as collaborative writing platforms that can be utilized for note-taking. The chapter also reviews existing data-mining and visualization tools for analyzing collaborative writing behaviors within such shared documents.

In order to better understand how collaboration through note-taking affects subsequent learning outcomes, the chapter examines the relationships between collaborative encoding behaviors and learning performance, with a subsection devoted to the relationship between learning and each of the

following, respectively: volume, sessions, turn-taking, and edits of others. Following this, the chapter continues to discuss the relationship between each of the aforementioned collaborative encoding behaviors and the quality of notes that students produce. The relationship between the storage quality of notes and subsequent learning performance is discussed in the subsection that follows. Finally, as quizzes are the primary measure of student learning performance in the present study, the role and the effectiveness of quizzes as a measure of learning performance is further discussed, particularly in higher learning contexts. The chapter closes with a discussion of gaps within the extant literature on note-taking generally, and collaborative note-taking specifically.

2.1 Note-taking and Learning

The present section focuses on note-taking a solo learning strategy undertaken by an individual learner in order to better understand and recall concepts expressed during lectures.

2.1.1 Note-taking as a learning strategy

Note-taking is a widely acknowledged strategy students employ to increase the depth of their ability to process (Bretzing & Kulhavy, 1979) and recall information from course lectures (Aiken et al., 1975; Oefinger & Peverly, 2020; Tindale et al., 2008). Nearly all university students take notes during lectures (Bonner & Holliday 2006; Castelló & Monereo 2005), and research has shown that taking notes is beneficial to their learning performance (Peverly et al. 2014). Learners take notes to record information and to facilitate their reflection on that information (Boch & Piolat, 2005). By taking notes, students can create external memory that can be accessed at a later date (Boch & Piolat, 2005). However, beyond this passive “external” memory, the act of writing down notes creates a store of “internal” memory, as note-takers return to the notes to re-read them as often as needed (Kiewra, 1987). Moreover, taking notes seems to mitigate the burden on learners’ working memories when

engaged in learning activities, thereby increasing their abilities to solve complex problems (Boch & Piolat, 2005).

The process of writing down important information from a lecture can also help learners remain engaged with what the speaker is saying, and this active engagement has been shown to improve students' learning outcomes and understanding of the content (Bohay et al., 2011). When students concentrate on the lecture and take notes on salient points, they are able to cognitively process the information, which enables deeper understanding (Salame & Thompson, 2020). Note-takers are also able to build connections among concepts in the lecture, which improves their ability to recall the information (Mayer, 1984).

2.1.2 The encoding-storage paradigm

In the literature, note-taking is generally viewed as an individual undertaking in which a single learner attempts to record important information from a lecture in order to increase understanding and recall. This cognitivist conceptualization of note-taking by an individual is often framed within a theoretical framework known as the encoding-storage paradigm (Di Vesta & Gray, 1972). Within this paradigm, *encoding* refers to a learner writing down information in an attempt to imprint information into the long-term memory (Peper & Mayer, 1978). The written record of relevant information that is produced as a result of such encoding is referred to as *storage* (Di Vesta & Gray, 1972), which can be reviewed later so that the learner need not attempt to recall every point mentioned in the lecture (Mueller & Oppenheimer, 2014). Therefore, while encoding directly benefits the learner by enabling the migration of information from the working memory to the long-term memory, encoding indirectly benefits the learner by creating storage, i.e., a written record of learning content that the learner can review at a later point in time (Di Vesta & Gray, 1972). This storage serves as a useful supplement to the imperfect long-term memory when reviewing notes, especially when studying for exams (Kiewra, 1989).

2.2 Note-taking and Technology

Technological advances have also greatly affected the way notes are taken, so the present section describes the role of computing devices in enabling students to type their notes and store them digitally, as well as how learning through online environments may affect the ways in which students take notes.

2.2.1 Portable electronics for typing notes

Technological advances in the form of widely-available wireless internet and increasingly portable laptops and tablets have led to a rapid increase in the use of laptops in university classrooms (Kay & Lauricella, 2011; Roberts & Rees, 2014). Notes that are recorded electronically are more easily edited, indexed, searched, and stored (Weaver & Nilson, 2005). Furthermore, because most people can type more rapidly than they can write with a pen and paper, they may exert less effort when typing notes. Research has shown that learners who type their notes are able to take a higher volume of notes as compared to learners who handwrite their notes (Mueller & Oppenheimer, 2014). However, the high speed at which people can type their notes may also present a disadvantage to learners, as the same study found that those who typed their notes were more likely to write down sentences verbatim from the lecture, which seems to have caused shallower processing of the information and to have led to worse performance on related exams as compared to those who wrote fewer but more original notes. The researchers surmised that this was because the latter approach requires more critical thinking in selecting which information is important enough to write down (Mueller & Oppenheimer, 2014).

2.2.2 Note-taking in online learning environments

In many online learning environments, students are given the opportunity to engage with course instruction asynchronously, viewing pre-recorded online lecture videos at their convenience. When doing so, learners have the ability to control the flow of information from a lecture video by pausing, rewinding, re-

watching, and skipping ahead as needed, and such behaviors have been shown to positively affect students' ability to take notes and to understand the topic of the lectures (Bruff et al., 2013; Fanguy et al., 2018; Veletsianos et al., 2016). For these reasons, some lecturers choose to record their live (synchronous) lectures in order to provide them to students as an online supplemental material. When this is done, students report improved concentration during the live lecture component of such courses because they expand or improve their notes at a later time when re-watching the lecture online (Balfour, 2006; Davis et al., 2009; Marchand et al., 2014). Such asynchronous presentation of course lectures is of particular benefit to students with disabilities, as they can listen to lectures at their own pace and take better notes as a result (Graves et al., 2011; Twigg, 2009). Prior work has described the importance and effectiveness of note-taking as a learning strategy in online learning environments and the need for further research on this topic in order to enhance self-directed learning (Zhu, Bonk, & Berri, 2022).

2.3 Collaborative Note-taking

Computing technologies, including those described in the preceding sections, have enabled students to collaboratively create their notes and share them with their peers, and the present section continues with a discussion of collaborative note-taking as a learning strategy.

2.3.1 Collaborative note-taking as a learning strategy

As illustrated in the previous sections, note-taking need not be a solo undertaking of a single learner. During the 1980s, an educational movement toward active learning encouraged instructors to provide "enhanced lectures" in which students could compare notes with one another during intentional pauses by the speaker (Bonwell, 1996). Ruhl et al. (1987) noted the positive short- and long-term benefits to students' recall of information when they were allowed to compare and clarify their notes together in this way. Luo et al. (2016) found that this form of collaboration among learners, occurring during a pause within a lecture, resulted in more original notes being recorded. Sharing notes in this way has a number of benefits for learners. Students are able to gain exposure

to a variety of perspectives and viewpoints that they can learn from, helping them to deepen their understanding of the course content. In addition, students may learn better note-taking practices through exposure to the styles and approaches used by their classmates.

The emergence of shared online word processors, such as Google Docs, has enabled even deeper levels of collaboration when taking notes. Rather than taking notes individually and then comparing and revising them collaboratively, as was done in the aforementioned pause procedure, learners can now compose their notes collaboratively from the beginning of the process until the end. Although research on the learning effects of online collaborative note-taking is still in its infancy, several studies have reported promising results. A study by Orndorff (2015) found that collaborative note-takers scored almost one letter grade higher in social science courses as compared to students who did not take collaborative notes. Student survey responses revealed that students tended to divide the labor of note-taking by assuming defined roles within the groups, a practice the author surmised helped to ensure the comprehensiveness of the notes. Fanguy, Baldwin, Shmeleva et al. (2021) conducted a study that specifically compared the learning outcomes of individual and collaborative note-takers. Collaborative note-takers were found to perform better on exams than individual note-takers, but individual note-takers received higher scores on writing assignments as compared to collaborative note-takers. These results suggest that the division of labor among members of note-taking groups may be a double-edged sword: while dividing up note-taking responsibilities may free up the cognitive resources of each learner to understand the material and perform better on exams, each member of a group is responsible for writing a smaller proportion of the notes than would be required if taking notes individually. Such division may lead to fewer opportunities to write about, and therefore deeply think about, concepts from the course.

Another concern about shared and collaborative notes that has been voiced is that students may skip classes (or skip watching assigned video lectures) if they know that a comprehensive set of notes created by their

classmates will be available to them. In addition to skipping course instruction, freeriders may choose to forego contributing to collaborative notes while potentially reaping the benefits of reviewing the storage their group mates produce. Interestingly, Kiewra (1989) found that learners who skipped lectures but reviewed notes taken by classmates who had attended did comparatively better on subsequent recall examinations and synthesis tests of the lecture content than those who listened to the lecture and recorded notes. Kiewra surmised that the original note-takers were so concentrated on the physical act of taking notes that they were unable to make connections among the course concepts. Those who borrowed notes, on the other hand, were cognitively freed up to make connections among course concepts. Similarly, as suggested by Orndorff (2015), it may be that collaborative note-takers, particularly less active ones, may be freed up cognitively to consider big picture issues within the learning content.

2.3.2 Social constructivist conceptualization of collaborative note-taking: Computer-Supported Collaborative Learning

While the cognitivist viewpoint underpinning the encoding-storage paradigm provides a useful explanation of the underlying mechanisms by which learners process and store information when taking notes, none of the studies in the literature on collaborative note-taking have conceptualized note-taking in this way. Perhaps researchers deem the encoding-storage paradigm insufficient to consider the complex social interactions and relationships among the members of a collaborative note-taking group. Instead, the literature on online collaborative note-taking has generally viewed this learning strategy like any other type of online collaborative writing, usually from the perspective of computer-supported collaborative learning (CSCL). In CSCL, learning is viewed as a process of interaction among learners using a technology (Stahl et al., 2006). CSCL research posits that learners that collaborate through the use of technology can benefit through the process of interaction with one another and from the subsequent group products that their interactions produce. Participation in interactive processes while collaborating leads learners to

deeper and more meaningful understanding of concepts being studied (Stahl et al., 2006). Moreover, research in CSCL suggests that learners co-construct new knowledge through these interactions, and this co-construction of knowledge often takes the form of a knowledge artifact as the group product (Stahl et al., 2014). Although these explanations of collaborative learning offer a useful way to conceptualize the complex relationships and interactions among the behaviors of group members and the notes they compose, they do not offer insight into the mechanisms by which the concepts represented in the notes enter the long-term memories of the individual members, which is a key contribution of the encoding-storage paradigm and a crucial issue with respect to note-taking.

2.3.3 Collaborative note-taking and technology

As computer technologies enable and facilitate continuous and ubiquitous collaboration among collaborative note-takers, this section will examine collaborative note-taking and note-sharing tools that are used in online learning environments, as well as collaborative writing platforms that can be utilized for note-taking. The section will also review existing data-mining and visualization tools for analyzing collaborative writing behaviors within such shared documents.

2.3.3.1 Collaborative note-taking and note-sharing tools in online learning environments

Beginning in the in the late 1980s, software tools were developed to facilitate collaborative writing in networked environments (Bonk et al., 1994). A tool known as WYSIWIS (what you see is what I see), enabled multiple users to simultaneously view a single document and to immediately see the changes being made to that document in real time (Stefik et al., 1987). In addition, WYSIWIS enabled users to share their perspectives and ideas while making changes to the document by using private chat boxes. Some packages of this software also enabled a turn-taking option in order to enable multiple users to

contribute writing to the document, albeit in a turn-based rather than simultaneous fashion (Stefik et al., 1988).

However, tools such as WYSIWIS limited collaboration to text and allowed only turn-based, rather than simultaneous, contribution to a document. Later technologies enabled users to write collaboratively and simultaneously, using a variety of media, including text, sound, graphics, and video (Bonk et al., 1994). Tools enabling this type of collaboration were called cooperative hypermedia. An example of this was the CSILE project, which was designed to enable learners to collaboratively set goals, build knowledge, generate new ideas, and develop a sense of ownership of their final product (Scardamalia & Bereiter, 1991). To this end, CSILE included both public and private note-taking features, enabling students to share their interpretations and understandings of course content (Bonk et al., 1994). In another example, a cooperative hypermedia tool known as MediaText enabled students to actively learn and create together via a common word-processing environment that provided access to a variety of media tools (Soloway, 1988). In a final example, KnowledgeBuilder was a cooperative hypermedia package that enabled students to share their written work on a common server and was primarily geared toward helping students develop effective writing strategies (Bonk et al., 1994). The package also provided access to a variety of tools for outlining, concept-mapping, drafting, and publishing (Freeze, 1991; Toews, 1989).

The aforementioned cooperative text and hypermedia tools of the 1980s and 90s provided a rich base from which collaborative note-taking tools were developed in the early 2000s (Steimle et al., 2007). While some of these tools were developed to help students take notes during the course itself, other tools were developed to facilitate note-taking and review after class (Steimle et al., 2007). Most of the tools enable collaborative note-taking or the ability to share notes, and several offer the function of pen-based annotation on tablet devices to better simulate traditional pen and paper note-taking.

In 2005, a technological tool called “Authoring on the Fly” (AOF) was developed by Lauer et al. (2005). The tool enabled students to anchor online discussions and notes to digital multimedia files including online lecture videos

and even audio recordings. These discussions and notes could be anchored both spatially and temporally to the multimedia files or documents, so that when multimedia is played back, the progression of the notes or discussion can be seen in a manner synchronous to the media itself.

In another example from around the same time, Livenotes provides a shared whiteboard system, enabling students to use tablets connected to wireless internet in order to take shared notes and discuss them in real time in small groups (Kam et al., 2005). The researchers compared the volume of notes written and the students' performance on subsequent quizzes between a treatment group of students who took notes individually and a treatment group who took notes in small groups using Livenotes software. The results revealed that the individual note-takers took fewer notes, on average, than constituent members of groups who took notes using Livenotes. Surprisingly, the study found no significant differences between the quiz scores of the two groups. Nevertheless, the authors pointed out that the collaboration opportunities created by the use of Livenotes inspired more active participation in note-taking than when students took notes individually (Kam et al., 2005).

Shortly thereafter, DyKnow software was developed to allow students to create a shared multi-page electronic notebook for each of their class meetings (Berque, 2006). This artifact is created by the instructor and shared with the students, and students can add their own private annotations. Just as with Livenotes, DyKnow provides a whiteboard feature, but in DyKnow, the instructor, rather than the students, draws sketches that are automatically exported to the students' devices. The instructor can also import PowerPoint presentation files and worksheets into the DyKnow platform, sharing them with students. Students can take their own private notes on any or all of these materials provided by the instructor. These notes can be stored on the DyKnow server and are automatically organized there by date, semester, and course, which can facilitate future reviewing sessions. In addition, the DyKnow platform allows the instructor to monitor the students' screens to make sure that they are on task and keeping up with the flow of material. Survey results showed that

both students and instructors found the DyKnow platform to be highly effective for facilitating note-taking and learning activities in their courses.

Around the same time, u-Annotate software was introduced by Chatti et al. (2006). This platform enables users to annotate online content, including webpages and documents, using a freeform digital ink feature via an electronic pen and tablet set up. In addition, the platform enables learners to save their annotations for future reviewing and to share their notes with others. The authors of the study posit that the traditional pen and paper style of notes is not synchronous with online content, which can cause notes to seem out of context. Moreover, students can misplace such analogue notes and are limited in their ability to share them with their peers, particularly in online learning environments. Therefore, u-Annotate was developed in response to this need.

Around a decade after these tools were introduced, a new crop of online note-taking tools was introduced in response to two important changes in the educational landscape. The first change was the wide availability of smartphones in the classroom, and the second was the emergence and popularity of MOOCs (massive open online courses). In response to the former, EduNotes was introduced to enable students to use their smartphones to take notes in courses (Popescu et al., 2016). Using this application, students can take notes on specific slides from a lecture and share them with their classmates. Moreover, students can even tag, rate, or comment on slides within their notes. The application features live updates and notifications, advanced search features, and privacy and filtering options, which can help students to simplify the management of their notes.

With regard to the latter, although many of the major MOOC platforms still lack integrated note-taking features (Veletsianos et al., 2015), there are some exceptions. Within edX, the MOOC platform provided by Massachusetts Institute of Technology, a note-taking system called NoteMyProgress was added that allows three main features to students: 1) the ability to write down and download notes while engaging in activities on the MOOC, 2) to monitor their engagement with learning activities within the MOOC, and 3) to monitor the time they are spending within the learning environment (Pérez-Álvarez et

al., 2017). According to student feedback, the note-taking feature of the tool was considered quite helpful to the students, who mentioned in their survey responses that they could write down questions about the learning material in their notes and share these to a discussion board to get feedback from their peers.

Veletsianos et al. (2015) commented on the importance of learners having the ability to share their notes with one another while enrolled in MOOCs, as doing so can maximize individual and group knowledge and interest in the course topic. One tool that enables this is VideoNot.es, which provides learners with a platform in which they can type their comments while a lecture video is playing within MOOCs including those hosted on Coursera, edX, Khan Academy, or Udacity, and what is written can be time-stamped and then shared on Google Drive (De Guchtenaere, 2013).

2.3.3.2 Online collaborative writing platforms for note-taking

In addition to note-sharing, technological advances have promoted students' ability to collaborate in the process of writing. There are a variety of technological tools students can use when writing collaboratively, including online word processors (Kessler et al., 2012), blogs (Sun & Chang, 2012) and wikis (Aydin & Yildiz, 2014; Lee & Bonk, 2009). All of these writing technologies present learners with opportunities to participate in composing a collaborative document at any time and from any location (Weng & Gennari, 2004). However, shared online word processors, such as Google Docs, provided as part of the Google Drive service (Kessler et al., 2012), may be the most suitable for collaborative note-taking. Google Docs allow an almost limitless number of collaborators to simultaneously write and edit a document (Judd et al., 2008). Moreover, members of a group do not need to be online at the same time in order to collaborate, as they may work asynchronously according to their convenience (Weng & Gennari, 2004).

2.3.3.3 Data-mining and visualization tools for analyzing collaborative writing behaviors

As the Google Docs platform is one of the most widely used for collaborative writing (Yim & Warschauer, 2017), several data-mining and visualization tools have been developed to harvest learning analytics from the documents that students create. Such data can shed light on the collaborative behaviors and processes that students engage in when taking collaborative notes by quantifying or visually depicting collaborative writing processes, particularly across a large number of documents (Yim & Warschauer, 2017). In this subsection, I will introduce three open-source tools for data analysis and visualization in the Google Docs platform.

The first of these is an open-sourced tool called SCAPES (Studying Collaborative Authoring Practices in Educational Settings), which can download and analyze the revision histories of up to 100 Google Docs per run. SCAPES provides collaboration information including the number of collaborators, the number of writing sessions each contributor engaged in, the number of instances in which edits were made, and the number of words each contributor added, deleted, or moved (Yim & Warschauer, 2017). Using these variables, researchers are able to examine how specific collaborative behaviors may relate to the quality of the final writing products that are created.

The second tool, DocuViz is a Google Chrome extension that provides a visualization of a Google Doc's revision history over time, indicating who contributed, their proportion of writing, and the time at which they contributed (Wang et al., 2015). Such data enable researchers to analyze how simultaneous writing and editing may impact the collaborative patterns of behavior within a Google Doc as it is being written, and further, the effect of such collaborative behaviors on subsequent writing quality (Wang et al., 2015).

The third tool, AuthorViz is a Google Chrome extension that color-codes sections of text contributed by each author within a Google Doc (Wang, 2016). This color-coding of text makes it possible for members of a collaborative writing (or note-taking) group to identify what was contributed by each author. Such identification may be useful to instructors, as well as to students themselves, in assessing the participation levels of members of a group. With

such information, passive students can be encouraged to participate in collaborative writing activities by their peers and/or by the instructor.

2.4 The Relationship between Collaborative Encoding Behaviors and Learning Performance

In order to better understand how collaboration through note-taking affects subsequent learning outcomes, this section examines the relationships between collaborative encoding behaviors and learning performance, with a subsection devoted to the relationship between learning and each of the following, respectively: volume, sessions, turn-taking, and edits of others.

2.4.1 Volume and learning performance

Within the encoding-storage paradigm, the process of writing down notes while listening to a lecture allows learners to encode meaningful concepts into their memories (Di Vesta & Gray, 1972). Accordingly, the act of writing down words is generally viewed as the primary form of encoding that students engage in during note-taking. Recent research provides support for this notion, as the ability to write more notes is correlated with improved outcomes on multiple-choice tests (Oefinger & Peverly, 2020). Such findings are in line with prior work that has consistently demonstrated a strong correlation between the volume of notes that learners take (i.e., the word count of the notes students write down) and their subsequent performance on assessment (Haynes et al., 2015; Kiewra, 1987). More specifically, a study by Mueller and Oppenheimer (2014) found a strong positive correlation between the volume of notes that learners wrote down and their ability to recall concepts from university lectures.

While the act of writing down words, or the creation of volume, is the most common type of encoding behavior that is examined in the literature on note-taking, there are other possible encoding behaviors that learners may perform, especially when they collaborate on group work. In such contexts, learners can engage in collaborative writing behaviors that involve direct or indirect interaction with each other's writing. As such, these behaviors may be viewed as forms of encoding that could have an effect on learning performance.

2.4.2 Writing sessions and learning performance

The number of writing sessions that note-takers engage in while constructing their notes is another writing behavior that may be viewed as a type of encoding. Writing sessions refer to the number of instances in which the learner returns to the online collaborative document in order to contribute volume. The literature suggests that increasing the number of such sessions may be beneficial to learning performance, as research has shown that, in general, learners who log in and interact more frequently in online learning environments outperform those who do not (Jo et al., 2015). Research has also shown that increases in the total number of sessions during collaborative learning activities positively affects individual learning outcomes (Manathunga & Hernandez-Leo, 2016). As an explanation of how writing sessions can positively affect learning outcomes in collaborative writing settings, a greater number of writing sessions among group mates can represent a more actively sustained collaborative endeavor over time, thereby enabling a learner's written contribution to garner more responses and feedback from their peers (Kessler & Bikowski, 2010). Research on CSCL has demonstrated that collaboration in writing flourishes and deepens when it is actively sustained, allowing learners to reap the benefits of being exposed to the various perspectives and viewpoints of their group mates (Kessler & Bikowski, 2010).

2.4.3 Turn-taking and learning performance

An important benefit of collaborative learning, and specifically CSCL, is that learners increase their exposure to diverse and complex viewpoints and interpretations on a given area of study (Kessler & Bikowski, 2010; Stahl et al., 2006; Trentin, 2009). In the case of collaborative note-taking, this means that learners can increase their comprehension of course material through interaction with their classmates' opinions and understandings of the learning content as represented within the collaborative notes they produce. One way that such interaction can be conceptualized is as a volley of contributions and responses by group members in a turn-based manner. The number of turns taken can signify the degree to which learners interact when communicating or collaborating (McKinlay et al., 1993). In a manuscript that is part of the current

dissertation project, my coauthor and I provided the first-ever operational definition of turn-taking in collaborative writing contexts (including note-taking) as follows: the degree to which learners interleave their writing with the writing of others (Fanguy & Chang, 2021). This definition enables turns to be used as a measure of interaction among group members in their collaborative writing process. Such turn-taking when constructing collaborative notes, where learners interleave their written contributions with one another, enables us to better understand the interactivity of the collaborative encoding process that is occurring.

2.4.4 Edits of others and learning performance

When taking collaborative notes, learners may not only contribute their own notes to the document, but may also choose to change or delete the contributions of their peers, as well. This process of editing the writing of other group members has been shown to deepen learners' comprehension of the concepts they are writing about (Blau & Caspi, 2009). A study by Yim et al. (2017) found that an increased amount of such editing correlated with an improvement in learners' ability to clearly articulate their thoughts and to utilize evidence to bolster their claims when writing collaboratively. In note-taking contexts, such editing of others' writing provides collaborators with increased opportunities to interact with the information recorded in the notes and to collaboratively encode such contents with their group mates. According to the CSCL perspective, such interaction enables learners to collaboratively construct meaning (Stahl et al., 2014).

2.5 The Relationship between Collaborative Encoding Behaviors and the Storage Quality of the Notes

The amount of volume that learners write and the extent to which they represent the concepts from instruction are manifestations of the depth of knowledge learners generate within their notes and the degree of their collaboration in note-taking (Adeniran et al., 2019; Doberstein et al., 2019; Ruhl

& Suritsky, 1995). As the notes that learners take represent the storage component of the encoding-storage paradigm, it is necessary to examine how the aforementioned collaborative encoding behaviors affect the quality of the notes. The literature on this topic suggests that increasing collaborative encoding behaviors could have beneficial effects on the storage quality of collaborative notes. In the case of sessions, a study by Kent & Cukurova (2020) found that more frequent login sessions by members of collaborative groups yielded higher quality discourse among them than when members logged in less frequently. In a similar vein, a study by Erkens et al. (2005) found that when groups self-reported greater awareness and planning of turn-taking when composing collaborative writing assignments, they were able to create higher quality documents as compared to groups who were less aware of turn-taking. In the case of note-taking specifically, studies have shown that learners may opt to edit the notes written by group mates in order to rectify misinformation, offer feedback, or add in information that was not included (Landay, 1999; Singh et al., 2004), each of which can lead to improvements in the quality of the notes.

2.6 The Relationship between the Storage Quality of the Notes and Learning Performance

Although some studies have suggested that the path to improved learning outcomes is through increasing the total number of words students write when collaborating (i.e., volume), other research has found that the path to improved learning outcomes is through the creation of more comprehensive learning artifacts within collaborative learning contexts (DeChurch & Mesmer-Magnus, 2010). Therefore, in the present dissertation, an important question must be asked: *What effect (if any) does the storage quality of notes have on students' learning performance?* Research by Einstein et al. (1985) found that when meaningful units of information are represented within students' notes, the students are more likely to be able to recall them. Similarly, Raver and Maydosz (2010) found that students who had access to complete notes that represented all of the concepts of interest from course lectures did better in subsequent learning measures than students who did not have access to a complete set of

notes. Accordingly, the literature suggests that the storage component of the encoding-storage paradigm provides important benefits to students' learning performance and that learners who have access to more complete notes should achieve superior learning outcomes to those who have less complete notes.

2.7 Quizzes as Measures of Learning Performance

Quizzes are frequently used as measures of students' understanding of course content (Roediger & Marsh, 2005). An important benefit of quizzes is that they have been shown in a number of studies to improve students' long-term recall of content from academic lectures as compared to additional study sessions or to not reviewing the contents of the lecture (Butler & Roediger III, 2007; Roediger & Karpicke, 2006). Moreover, computer-based quizzes enable instructors to better facilitate learning by helping them to gauge the proportion of students who are struggling with understanding the course material, thereby enabling the moderation of instructional content and pace accordingly (Marks, 2015). For reasons such as these, quizzes may serve as a valuable component in online learning environments in which learners are required to complete computer-based assignments for homework and to engage in collaborative learning activities during live class sessions.

When considering types of quizzes, multiple-choice quizzes are particularly common in higher education courses (Roediger & Marsh, 2005). While the use of multiple-choice items for assessment has sometimes been criticized in the literature, instructors tend to view multiple-choice quizzes as indispensable because they offer a means of instant and automatic grading for numerous quizzes, which is of particularly high importance in large undergraduate courses in which open-ended items, such as essay or short-answer items, may be too cumbersome or unreliable (Little et al., 2012). For these reasons, multiple-choice quizzes are extremely common in MOOCs and many other online courses which have high enrollment (Colvin et al., 2014). Despite these advantages, there are a number of criticisms of multiple-choice quizzes. One such criticism is that multiple-choice quizzes are limited in their ability to assess complex learning (Frederiksen, 1984). Others have argued that

such quizzes do not cause students to engage in the types of retrieval processes that result in long-term recall of information (Chan et al., 2006; Foos & Fisher, 1988). In addition, several studies have shown that multiple-choice items can lead to misinformation. These studies found that exposing learners to plausible but incorrect answer options caused them to evaluate such “lures” as more likely to be true than novel, factual answer options, though never quite rising to the rated truth levels of true statements (Roediger & Marsh, 2005; Toppino & Brochin, 1989; Toppino & Luipersbeck, 1993).

Despite these criticisms, a large body of research has shown that there are important learning benefits to multiple-choice questions as a form of assessment. For instance, in spite of the possibility of creating false knowledge, a study by Roediger and Marsh (2005) found a significantly positive testing effect when learners were required to take a multiple-choice exam as part of their preparation for an exam testing their general knowledge. A study by Little et al. (2012) found that, with proper construction, multiple-choice items improved learners’ ability to recall information they had been previously tested on. In the study, a properly constructed multiple-choice item was defined as one in which all answer options are plausible, but not plausible enough to cause unfairness. The researchers also found that multiple-choice items improved students’ recall of information related to incorrect answer options, which was an improvement when compared to cued-recall exams. In addition to these benefits, multiple-choice items provide higher grading reliability and expose students to a larger variety of items in less time than many other constructed response items, including essay exams (Walstad & Becker, 1994). A final criticism of multiple-choice testing is that assessing recall of factual information does not guarantee that students possess competency; this is because a high degree of competence requires a learner to integrate knowledge with attitudes and communication ability (McCoubrie, 2004). However, research by Glaser (1984) showed that knowledge of a specific domain is the single best predictor of expertise. This suggests that multiple-choice items provide a valid method of assessing competence.

2.8 Gaps in the Literature on Collaborative Note-taking

Research on collaborative note-taking is still in its infancy, as many of the technologies that have enabled the spread of this learning strategy, e.g., shared online documents, have only become widely available to the public in the late 2000s. Because of the relative recency of collaborative note-taking as an educational practice, the literature on this topic remains rather sparse and underdeveloped. There are several layers of issues that remain unaddressed in the current literature, including gaps in theory, knowledge, pedagogy, methodology, and technology. Each of these will be described in detail in the subsections that follow.

2.8.1 Gap in theory: Mending the theoretical perspectives of encoding-storage with CSCL

The cognitivist perspective of the encoding-storage paradigm provides the theoretical framework for much of the literature on traditional note-taking, where an individual learner takes notes by him/herself. A key benefit to this framework is that it explains a means by which note-taking may improve students' recall of information. Despite its prevalence, the encoding-storage paradigm has never been used as a theoretical framework in collaborative note-taking research, perhaps because, in its current form, it does not account for the effects of social processes that students engage in when they collaborate. Researchers have instead utilized social constructivist perspectives when conducting research on collaborative note-taking, most often from CSCL, enabling them to account for the collaborative processes that occur when taking notes in groups. While useful, this CSCL perspective lacks the aforementioned explanatory power of the mechanisms leading to improved recall. Therefore, a new theoretical perspective is needed, ideally one that can maintain this explanatory mechanism for how information is imprinted into the memory during note-taking and can expand this concept to account for the collaborative processes that learners engage in when taking notes in groups.

2.8.2 Gap in knowledge: Collaborative processes and products

With regard to what is known about collaborative learning, the review of literature in this chapter has revealed three important gaps. These gaps relate to 1) the collaborative processes learners engage in, 2) the products that result from this collaboration, or 3) the combination of the two. The first gap relates to explaining collaborative behaviors and processes in note-taking. As mentioned earlier, there is only a sparse amount of research on the topic of collaborative note-taking, with early results showing benefits including higher course grades (Orndorff, 2015) and more inclusivity in the learning environment (Harbin, 2020). However, thus far, the literature lacks rigorous research attempts to explain how and why such benefits occur; instead, extant research has generally relied on self-reported student survey results or speculation. What is needed now is a systematic examination of the collaborative processes and behaviors that students engage in when taking collaborative notes. The second gap relates to the effect of the storage quality of the notes on the subsequent learning benefits. Thus far, no study in the literature has rigorously examined or evaluated the quality of the notes that students produce when taking notes collaboratively. As a result, little is known about the relationship between the quality of the notes groups produce and their subsequent learning outcomes. Research on this topic will fill an important gap in the literature. A third gap related to this is that much of the CSCL-informed research on collaborative writing generally, and note-taking specifically, has not clearly distinguished the collaborative processes learners engage in from the products that result from this collaboration. The conflation of these two potential drivers of collaborative learning hinders a more nuanced understanding of how collaboration may benefit performance, and research that attempts to distinguish collaborative processes from products may enhance our understanding of how the former affects the latter, and how each affects learning.

2.8.3 Gap in methodology: Analysis of collaborative note-taking at the individual and group levels

The literature generally tends to focus on the effect of collaborative note-taking on the learning performance of individual members. However, it is also

important to examine the effects of collaboration on the entire group, as membership in a group that engages in certain collaborative practices might affect the learning performance of constituent members, even if those members do not personally participate in these said collaborative practices. Moreover, certain collaborative behaviors might have differing effects on the learning performance of the individual who performs them and on his/her group mates. For example, how are group learning outcomes affected when a single member of the group dominates contribution to the shared notes? It is possible that such behavior by an individual might benefit the individual but harm the outcomes of the group, or conversely, harm the individual but benefit the group. The extant literature on collaborative note-taking has generally neglected such group-level analysis of the collaborative processes and effects on subsequent learning performance. Such analysis is needed but is somewhat complicated to perform because the group- and individual-level collaborative data are not independent and involve levels of nested hierarchies. Methodological approaches, such as the one used in the present study, are needed that can simplify this process, facilitating this much needed line of research in collaborative note-taking specifically, and in other types of collaborative learning as well.

2.8.4 Gap in pedagogy: What constitutes effective collaborative note-taking?

The literature reviewed in this chapter suggests the great potential of collaborative note-taking to improve the learning outcomes of students in a variety of ways: 1) by reducing the cognitive burden required to take notes while attempting to listen to and understand a lecture, 2) by providing students with a more comprehensive set of collaborative notes than those they would have produced on their own, and 3) by exposing students to a variety of insights and perspectives from their peers. However, as previously mentioned, extant research on collaborative note-taking lacks rigor in its examination of the exact collaborative processes and behaviors students engage in when constructing their notes, of the quality of the notes that they produce, and of the effects of these behaviors on learning outcomes at the individual and group levels of

analysis. Such gaps in the literature have led to a lack of actionable recommendations for instructors who wish to implement and facilitate collaborative note-taking as a learning activity in their courses. The recommendations for practitioners provided by existing studies are generally vague, suggesting that collaboration is beneficial to student learning outcomes, neglecting to describe what types of collaborative behaviors and processes are beneficial, to what extent, and for whom. There are also no recommendations in the current literature regarding the value of note quality, i.e., to what extent completeness affects subsequent learning performance. If recommendations on such topics could be given based on the results of rigorous research, practitioners would be better able to identify successful collaborative note-taking strategies and to aid their students in engaging in such practices.

2.8.5 Gaps in technology: Insufficient software tools

The present literature review has described a number of software tools that were created to facilitate collaborative note-taking, particularly in online learning environments. However, none of these tools has become widely used yet. One reason for this may be that most of these tools require students to install unfamiliar third-party software to their devices in order to take notes collaboratively, which could introduce unnecessary complication and affect their willingness or even ability to participate. For this reason, many of the studies on collaborative writing and note-taking have required students to use the Google Docs platform, as it is widely known and used by students and no sign-up is required beyond having a Gmail account, the most widely subscribed email service in the world (Elias & Petrova, 2019). However, Google Docs also presents issues with regard to convenience, albeit to instructors rather than students. This is because ideally instructors, rather than students, should be responsible for creating and sharing Google Docs with the student groups that will use them. This is advisable because when instructors do so, they can help to ensure consistency in the format of the note-taking documents, can provide continuous access to the document to all group members, and can monitor the progress of students as they take notes. However, creating and sharing large

numbers of Google Docs is a cumbersome task for instructors. In order for collaborative note-taking to become a more widespread practice, software solutions are needed that will simplify this process and reduce the burden on instructors.

An additional benefit of the instructor being the creator, and therefore owner, of the Google Docs for collaborative note-taking is that ownership enables the instructor to data-mine the documents in order to analyze the collaborative data students produce. This could be done for pedagogical purposes, e.g., grading of participation in note-taking, or for research purposes, as in the present study. Learning analytics and visualization tools, such as SCAPES, DocuViz, and AuthorViz, enable instructors and researchers to data-mine such collaborative learning data from Google Docs rapidly and easily. One aspect of collaboration that has been neglected in the field of collaborative writing as a whole is the extent to which individuals and groups take turns when contributing writing to a document. Prior work was reviewed in this chapter showing that groups that reported attention to and awareness of turn-taking produced documents of higher quality than groups that did not (Erkens et al., 2005). However, there is surprisingly sparse literature on the effects of turn-taking in the context of collaborative writing, and this is because no operationalized definition for turn-taking exists in this context. Turn-taking is acknowledged to be an important aspect of collaborative learning generally (McKinlay et al., 1993), so research into the effects of turn-taking in collaborative writing contexts is worthwhile. Therefore, there is a need for an operational definition for turn-taking so that turn-counting software can be developed or so that turn-counting features can be added to existing learning analytics tools.

Chapter 3: Research Methodology

The present study examines the learning experiences of 357 students engaged in collaborative note-taking in a graduate-level Scientific Writing course. Specifically, the effects of individual- and group-level collaborative encoding behaviors are analyzed in terms of their effects on the quality of the notes that are produced and on subsequent learning performance at the individual and group levels. The study further analyzes the effects of note-taking quality on subsequent learning performance. The present chapter describes the research methodology employed in this study. In order to address the research question, quantitative and qualitative data have been incorporated into a mixed-method design. Among many possible mixed-methods research designs, the most widely used and known are convergent parallel, embedded, transformative, multiphase, explanatory sequential, and exploratory sequential (Watkins & Gioia, 2015). The present study utilizes an explanatory sequential mixed-method design in order to address the research questions. In this approach, quantitative data is collected and analyzed first, and then qualitative data is collected and analyzed (Creswell, 2012). In the present study, quantitative methods provide the primary means of answering the research questions, and qualitative data supplement these findings, helping to add further triangulation and context (Creswell, 2012). The specific aims of the present study are to analyze how encoding affects storage, how encoding affects learning performance, and how storage affects learning performance in the context of collaborative note-taking. To do this, a correlational research approach is utilized. That is, the present study uses an explanatory sequential design that combines correlational quantitative data (collaborative encoding variables, a note-taking completeness variable, and quiz scores) and quantitative data (semi-structured interviews).

3.1 Research Paradigm

Among numerous theoretical dispositions described in the literature on research paradigms, there are two widely-subscribed paradigms within the field of educational research, namely positivism and interpretivism (Lincoln & Guba, 1985), that inform quantitative and qualitative research designs, respectively.

However, some have argued that mixed-methods research designs, which involve the collection and analysis of both quantitative and qualitative data (Punch & Oancea, 2014), may be situated within a different paradigm, namely pragmatism (Creswell, 2012). The present study uses a mixed-methods approach that is informed by the research paradigm of pragmatism, as will be explained in detail in the subsections that follow.

3.1.1 Positivism

Positivism, which emerged as a paradigm in the 19th century, was established by August Comte and Herbert Spencer (Parahoo, 2014). According to Comte, real knowledge can be derived from the human senses and further advanced by experimentation (Mack, 2010). The positivist school of thought also maintains that reality exists independently of the experiences of the individual and that the world is controlled by the law of causation, which can be tested (Gibbs, 2007). Positivist research is characterized by the use of the scientific method and statistical analysis in order to obtain generalizable findings (Mack, 2010).

3.1.2 Interpretivism

Interpretivism arose from Edmund Husserl's phenomenology, as well as the hermeneutics of his contemporaries (Mertens, 2014). The central tenet of interpretivism is that people gain knowledge through their own experiences rather than through objective observation from the outside (Mack, 2010). The interpretivist position is compatible with the concept of social and personal realities and seeks to gather detailed information about the feelings of subjects in a study through the collection and interpretation of qualitative data (Pring, 2015). Due to its subjective rather than objective nature, qualitative research proceeds with a researcher examining and interpreting the data by describing themes within the data and drawing conclusions about the feelings and beliefs of the research subjects (Creswell, 2014).

3.1.3 Pragmatism

Pragmatism began in the United States in the 1870s with foundational contributions from Charles Sanders Peirce, William James, and John Dewey (Hookway, 2008). Pragmatism does not commit to a single philosophical system, but rather focuses on the "what" and "how" of the topic of research (Creswell, 2014, p. 40). The pragmatic paradigm places a central focus on the research questions and utilizes all approaches to gain a clearer understanding of the problem (Creswell, 2014). Therefore, the methods of collecting and analyzing data are selected without philosophical loyalty to a particular paradigm and are instead chosen on the basis of their likelihood to provide insight into the research questions (Mackenzie & Knipe, 2006). Pragmatism is generally viewed as the paradigm providing the philosophical underpinnings for mixed-methods research (Tashakkori & Teddlie, 2003). Mixed-methods approaches to research originated as a response to intense debate between adherents of the positivist and interpretivist paradigms (Feilzer, 2010). Positivism and interpretivism differ in their perspectives of reality: positivists maintain the existence of one objective reality while interpretivists hold that multiple subjective realities exist (Teddlie & Tashakkori, 2009). Moreover, positivism emphasizes the importance of separation between the researcher and the subject being studied, while interpretivism holds that the researcher should interact with the subject being studied (Mackenzie & Knipe, 2006). To mend these perspectives, pragmatism allows for the use of both quantitative and qualitative methods to be combined in a mixed-methods approach (Mackenzie & Knipe, 2006). According to pragmatism, single or multiple realities can be utilized in order to address different types of research questions (Creswell & Plano Clark, 2011). Thus, mixed-methods research is often guided by the philosophy of pragmatism (Feilzer, 2010), as in the present study, and such research may employ data collection techniques found in the positivist and interpretivist paradigms, such as experiments and interviews (Mackenzie & Knipe, 2006).

3.2 Research Design

In quantitative research, experimental methods and quantitative measures are utilized in order to test hypotheses and analyze the relationships among variables (Hoepfl, 1997). There are a number of advantages of quantitative research methods: 1) data collection and analysis tend to be relatively rapid, 2) research findings are often generalizable to various populations, and 3) instruments can be used to measure variables (Johnson & Onwuegbuzie, 2004). Such quantitative instruments are created in order to gather data to address the research questions that are asked before beginning the research process (Creswell, 2012). Measurement and statistics are vital to quantitative research due to the relationship between mathematical interpretation and observation (Hoy & Adams, 2010). There are two kinds of quantitative research: experimental and nonexperimental (Creswell, 2012). Correlational research is a type of nonexperimental research where two variables are measured so that their statistical relationship can be assessed; the defining feature of this type of research is that neither variable is manipulated (Price et al., 2015). Researchers who wish to analyze statistical relationships among variables may choose to utilize a correlational rather than experimental research design for two reasons: 1) when the researcher does not believe that there is a causal relationship between the variables or 2) when it is impractical or impossible for the researcher to manipulate the variables being measured (Price et al., 2015).

In the present study, a correlational research design has been used instead of an experimental one because the primary aim is to better understand the effects of encoding on storage and learning performance when taking collaborative notes rather than to compare the effects of individual versus collaborative note-taking, which my coauthors and I have already done in prior studies (Courtney, Costley, Baldwin et al., 2022; Fanguy, Baldwin, Shmeleva et al., 2021). In the present study, I wish to measure specific collaborative encoding behaviors to better understand their effects on the quality of notes produced and the learning performance of groups and their constituent members. Therefore, the present study has used between-individuals and between-groups levels of analysis in order to examine the effects of

collaborative encoding behaviors on learning performance at the individual and group levels, which is explained in greater detail in a subsequent section. This quantitative research approach has been followed by qualitative data collection in the form of semi-structured interviews with 13 participants in the study regarding their experiences with collaborative note-taking during the semester. This qualitative data was collected in order to validate and contextualize the quantitative findings, providing triangulation for the results as part of an explanatory sequential mixed-method research design.

3.3 Research Questions

This dissertation examines the learning experiences of students engaged in collaborative note-taking in an online Scientific Writing course. The study seeks to understand the relationships among the processes of collaboration, learning performance, and knowledge creation among individuals and groups. Based on these aims, the study is guided by five primary research questions with constituent hypotheses.

RQ1. What is the relationship between collaborative behaviors and learning performance at the individual level?

H1: When students engage in more collaborative encoding behaviors, they perform better on quizzes.

H1a: When students contribute a higher volume of words, they perform better on quizzes.

H1b: When students have more frequent writing sessions, they perform better on quizzes.

H1c: When students take more turns, they perform better on quizzes.

H1d: When students edit more of their group members' writing, they perform better on quizzes.

RQ2. What is the relationship between collaborative behaviors and learning performance at the group level?

H2: When groups engage in more collaborative encoding behaviors, they perform better on quizzes.

H2a: When groups produce a higher volume of words, they perform better on quizzes.

H2b: When groups have more frequent writing sessions, they perform better on quizzes.

H2c: When groups take more turns, they perform better on quizzes.

H2d: When groups edit more of their group members' writing, they perform better on quizzes.

RQ3. What is the relationship between collaborative behaviors and note completeness at the group level?

H3: When groups engage in more collaborative encoding behaviors, the completeness of their group notes improves.

H3a: When groups produce a higher volume of words, the completeness of their group notes improves.

H3b: When groups have more frequent writing sessions, the completeness of their group notes improves.

H3c: When groups take more turns, the completeness of their group notes improves.

H3d: When groups edit more of their group members' writing, the completeness of their group notes improves.

RQ4. What is the relationship between completeness and learning performance at the group level?

H4: When groups have higher levels of completeness, they perform better on quizzes.

3.4 Research Context of the Institution and Course

In order to provide a clear context for the present research, this section provides detailed descriptions of both the institution where the study was conducted and the course that was examined.

3.4.1 Institutional context

In 1971, the Korea Advanced Institute of Science and Technology (KAIST) was established in order to foster a new generation of scientists and engineers that could accelerate Korea's development (Korea Advanced Institute of Science and Technology International Office [KAISTIO], 2020). KAIST has succeeded impressively in this mission, and recently, it has broadened its mission to include more international goals of providing education, cutting-edge research, and leadership "in innovations to serve the happiness and prosperity of humanity" (Korea Advanced Institute of Science and Technology [KAIST], 2020c). As of 2020, the student population of KAIST was 10,504 (KAIST, 2020b), and the overwhelming majority of KAIST students major in STEM fields.

In order to achieve the aforementioned objectives of fostering world-leading scientists and engineers to assist Korea's development and in order to address global challenges, KAIST strives to offer high-quality education and excellent research environments. Prior to the COVID-19 pandemic, over 90% of courses offered at KAIST were conducted face-to-face, typically with a faculty member providing lectures with slides, answering students' questions, and leading group discussions. Although there were no fully online courses for

credit prior to the pandemic, KAIST offered flipped courses (or blended, a mixture of face-to-face and online instruction), and these courses were called “Education 4.0 courses” (KAIST, 2020a).

The Education 4.0 initiative (hereafter, Edu 4.0) began in 2012 as part of the establishment of a broader institutional strategy known as “KAIST Vision 2031”. One of the strategies of the Edu 4.0 initiative was to decrease the prevalence of traditional face-to-face lecturing, instead providing lecture contents in online video format so that students would be able to access these contents at their own pace. By removing face-to-face lectures from courses, instructional time could be freed up for active learning opportunities and group work, where students could apply what they had learned by watching online lecture videos (Fanguy, Lee, & Churchill, 2021; Horn, 2014). Note that the term “Education 4.0” was essentially KAIST’s branding on the existing flipped model of instruction and should not be confused with the more common definition of Education 4.0, which refers to learning approaches that are closely aligned with the 4th Industrial Revolution (Hussin, 2018).

Due to mandates by the Korean government due to the sudden outbreak of the COVID-19 pandemic, the Provost of KAIST sent an email to all faculty members and students that all courses in KAIST would be migrated to fully online delivery. Fully online teaching continued through 2021 and 2022, with some classes resuming face-to-face meetings in the Spring semester of 2022. Face-to-face courses were officially resumed in Spring of 2022.

3.4.2 Course context

As one of the aforementioned aims of KAIST is to conduct world-leading research, KAIST has placed a high priority on the publication of research outcomes in academic journals among its faculty and students. In most of the graduate degree programs within the university, students are required to publish at least one (sometimes more) manuscripts in journals included in the Science Citation Index (SCI). In order to help students to meet this requirement, many departments within the university require students to take Scientific Writing (CC500), a graduate-level course designed to help students write up the

results of their research into manuscript form for publication in a peer-reviewed journal. During this course, students receive instruction on research writing and compose an academic manuscript on their graduate research, turning in the parts of this manuscript section by section to the course instruction in order to get feedback, corrections, and assessment. This credit course is offered every semester by the School of Digital Humanities and Computational Social Sciences at KAIST. The present study examines the educational experiences of 357 graduate students majoring in STEM who were participating in online collaborative note-taking in 17 different class sections of the Scientific Writing course at KAIST. I was the instructor for each of these sections of the Scientific Writing course.

The Scientific Writing course examined in this study was taught entirely in English, as is the case for the vast majority of courses taught at KAIST. Prior to being admitted to the university, all students had to earn an upper-intermediate and advanced English level score on the TOEFL exam. Students who did their undergraduate university education at KAIST were required to take English as a foreign language courses for the first two years of their degree programs. Because students had relatively good English proficiency, there were no major issues with English language communication. Students were encouraged to speak in English during all group and pair work in order to help further develop their English proficiency and to enable full participation of international students, which accounted for 46 of the 357 participants in the study.

I taught this course in a flipped format as part of the Edu 4.0 initiative. The course began with an orientation week in which students became acquainted with the instructor, one another, the learning management system, and the aims and objectives of the course. Following orientation week, the semester consisted of 10 instructional weeks that included asynchronous online instruction followed by a once-weekly live meeting where students would engage in active learning in pairs or small groups in order to apply and practice what they had learned from watching online lecture videos. Each week, before the live class meeting, students were required to watch a batch of online lecture

videos related to various concepts from the online video lectures including the functions of each section of the research manuscript, conventions of academic writing (including grammar and style), ethical issues related to publishing research, the processes of submitting a manuscript, and peer review.

In order to help students to better understand the contents of these videos, I asked students to self-select into small groups of 4 or 5 members. To assist them with grouping, I created an application within the course LMS in which students could choose a group, and their choice was visible to all course participants. I allowed students the option of changing their group choice for up to seven days so that they would be able to select into groups containing familiar class members such as friends or labmates. After the seven-day group selection period, I randomly assigned any ungrouped students into groups that had fewer than five members. I created 10 Google Docs for each group so that they could write online collaborative notes on the contents of the 10 respective weeks of instruction during the semester. To assess each student's comprehension of the contents of each lecture video, students were required to take 10 online quizzes covering the contents of the videos that they had watched for each of the 10 instructional weeks. Students were allowed to take the quizzes at their leisure on the course learning management system, but a final deadline for taking each quiz was imposed just before the start of the live class meeting for a given instructional week. During the live class meetings, students engaged in one of the following two types of collaborative group work: 1) students wrote an example of a given section of a research manuscript based on a research scenario given to them by the course instructor or 2) students worked in pairs to provide one another with peer editing and feedback on their own research writing for a given section of the manuscript. At the end of every two-week period students were required to turn in an individual writing assignment, which was one of the following sections of a journal manuscript they were writing during the semester: 1) Introduction, 2) Methodology, 3) Results, 4) Discussion and Conclusion, 5) Abstract, and 6) Title and References. The structure and pacing of instructional content and activities of the course are depicted in Table 3.1

Table 3.1

Weekly Learning Content and Activities in the Scientific Writing Course

Week	Topic	Video #	Note #	Quiz #	In-class activity	Assignment
0	Course Orientation	NA	NA	Pre-test	Pre-test	Topic Proposal
1	Introduction	1 – 8	1	1	Group writing activity: Introduction	1st draft of Introduction
2		9 – 13	2	2	Peer editing Introduction	Final draft of Introduction
3	Methodology	14 – 17	3	3	Group writing activity: Methodology	1st draft of Methodology
4		18 – 19	4	4	Peer editing Methodology	Final draft of Methodology
5	Results	20 – 23	5	5	Group writing activity: Results	1st draft of Results
6		24 – 28	6	6	Peer editing Results	Final draft of Results
7	Discussion & Conclusion	29 to 32	7	7	Group writing activity: Discussion & Conclusion	1st draft of Discussion & Conclusion
8		33 – 36	8	8	Peer editing Discussion & Conclusion	Final draft of Discussion & Conclusion
9	Abstract, Title, and References	37 – 44	9	9	Group writing activity: Abstract	1st draft of Abstract, Title, and References
10		45 – 50	10	10	Peer editing Abstract, Title, and References	Final draft of Abstract, Title, and References

Note. A numbered list of online lecture video topics can be found in Appendix One.

In terms of grading, the course was given in a Pass/Fail format. In order to pass the course, students had to turn in every written assignment and take every quiz during the semester. In addition, students were required to earn a final grade of 60% or higher, so that students with final grades of 59% or lower were assessed failing grades. Course point totals were as follows. Individual writing assignments accounted for 60% of the course grade, with each of the following assignments counting for 10% of the course total, respectively: 1)

Introduction, 2) Methodology, 3) Results, 4) Discussion and Conclusion, 5) Abstract, and 6) Title and References. Weekly online quizzes accounted for 30% of the course grade, with each of 10 respective quizzes accounting for 3% of the course total. Each student was also scored on participation in collaborative note-taking activities, and these note-taking scores accounted for 10% of the course total. During each instructional week, notes were assessed by the course teaching assistant to make sure that each student contributed at least some notes to the respective Google Doc. If a student contributed notes, a score of 1% was given, and if no notes were contributed, a score of 0% was given, for each of 10 instructional weeks. At the end of the semester, these scores were summed for the 10% grade assessed for note-taking. Because the course was taught in pass/fail format and the threshold for passing was relatively low at 60%, no student failed the course during any of the four semesters of data collection. Students rarely dropped out of the course, so it was never necessary to reformulate groups, although some groups ended up with three members rather than four or five. Importantly, care was taken so that exactly the same instructional procedures and assignments were used in each of the four semesters of the data collection period so that the data could be compiled into a large dataset.

3.5 Quantitative Research Design

This study analyzes the educational experiences of 357 students participating in collaborative note-taking in 17 sections of a graduate-level Scientific Writing course at KAIST. Each of the 357 students self-selected into 81 groups, with an average group size of 4.41 students. Specifically, there were 5 groups of 3 students (these three-person groups occurred due to students dropping out of the course), 38 groups of 4 students, and 38 groups of 5 students. These small group sizes were used because they have been shown to increase learner-to-learner interaction in online learning environments (Caspi et al., 2003). More specifically, research on collaborative note-taking has shown that students prefer to work in groups of 3-5 students (Orndorff, 2015).

Participant demographics are shown in Table 3.2. All participants majored in STEM fields.

Table 3.2

The Demographic Variables for the Participants (N = 357)

Gender	**Male**	**Female**		
	261	96		
Nationality	**Korean**	**Foreign**		
	293	64		
Degree	**Masters**	**Ph.D.**		
	268	89		
Age	**Min**	**Max**	**Avg**	**SD**
	20	55	26.97	4.55

3.5.1 Online lecture videos

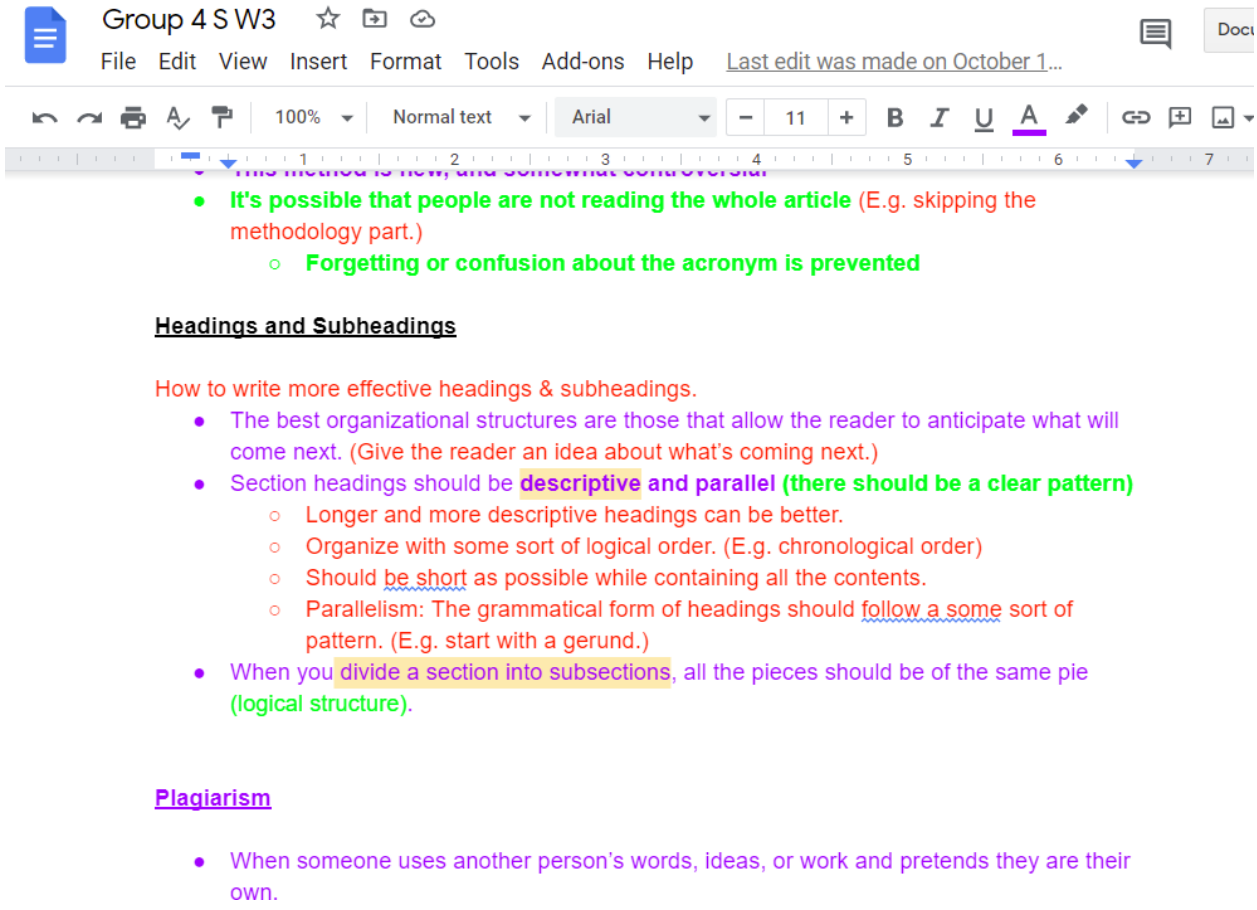
All lecture contents for the course were provided in streamable online video format on the learning management system provided by the university. There were a total of 10 instructional weeks in the course, with each week containing between 4 and 8 lecture videos, with a total of 50 videos for the semester (see Appendix One for a list of all video lectures and their respective run-times). The durations of the online lecture videos ranged from 4:56 to 24:50, with a mean duration of around 12 mins. During each of the 10 weeks of instruction, students were requested to take collaborative notes in the aforementioned set of small groups of 3 to 5 students. As the lecture videos were provided in streamable format online on the learning management system, students could watch the videos as often as desired and were also able to press pause, rewind, fast-forward, or engage in frame-seeking behaviors as needed.

3.5.2 Online collaborative note-taking

During each instructional week, each note-taking group took their notes within a designated Google Doc that was created and monitored by the course instructor. In other words, each note-taking group took notes within a total of 10 Google Docs corresponding to the 10 instructional weeks of the semester. The “share” permissions within these Google Docs were set so that students were required to log in with their own Google accounts in order to view or contribute to the notes. This was done to prevent anonymous contribution to the notes, which would have made it impossible for me, as the instructor and researcher, to differentiate the contributions of each member. Group members also may have benefited from being able to distinguish their contributions to the documents so that they could check that each member was contributing meaningfully to the document and so that freeriding behaviors could be addressed. In order to create these Google Docs and share them with the appropriate student groups, a customized computer system called Collab_Notetaking was created and utilized. More information about this software can be found in “Section 3.7: Custom Software Tools for Quantitative Data Collection of this dissertation”. Students were asked to complete note-taking activities no later than the day before the live meeting for each instructional week, allowing them approximately 6 days to complete their notes. Students were allowed to meet briefly for ten minutes at the beginning of the class Zoom meeting once a week to discuss their note-taking and to plan out how to take notes for the upcoming week. All groups wrote their notes in the English language, as this was a requirement of the course; however, two of the note-taking groups also provided translations of the notes in Korean language beneath the English notes for each of the ten instructional weeks. As there as a substantial foreign population within the courses, all students were encouraged to speak in English during group meetings. A screenshot of a set of collaborative notes taken during the pilot study of this research project is shown in Figure 3.1.

Figure 3.1

Sample Collaborative Notes Taken Online Using Google Docs



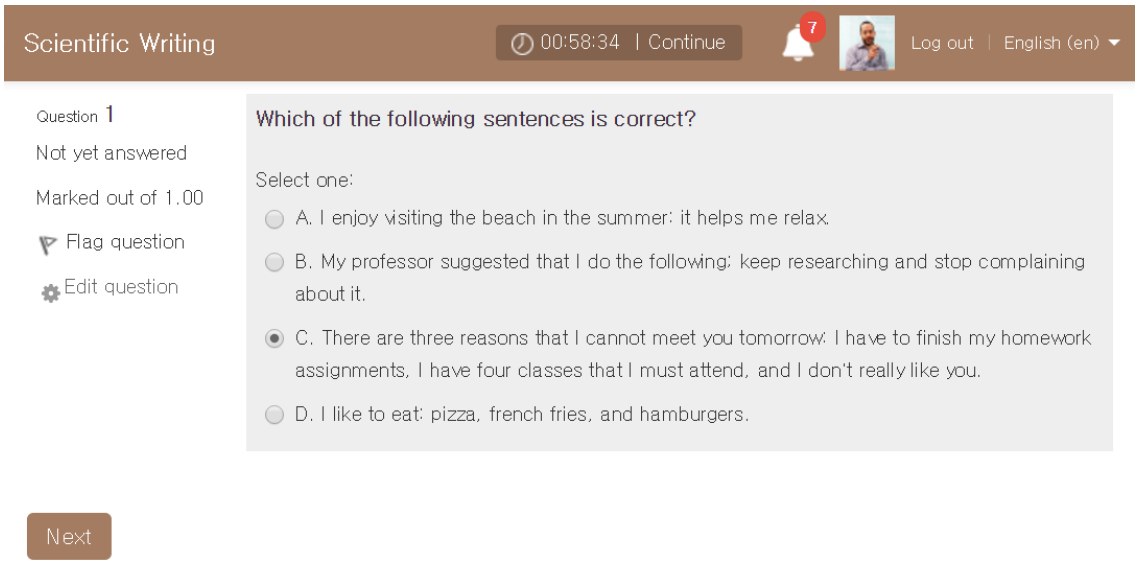
3.5.3 Quizzes

Students were also required to take 10 online quizzes during the semester, corresponding to each instructional week. The quizzes were given in order to assess students' understanding of course concepts, as quizzes have been shown to provide a good measure of the learners' comprehension of the concepts of a course (Herold et al., 2012; Kamuche, 2011). The course instructor encouraged the students to refer to the collaborative notes they had taken when taking the related quizzes. The quiz items were designed to cover topics from the lecture videos, which included a range of issues such as the functions of each section of the research manuscript, conventions of academic

writing (including grammar and style), ethical issues related to publishing research, the processes of submitting a manuscript, and peer review. I deemed these topics to be appropriate for assessment with quizzes. A screenshot of a quiz item related to the use of the colon and semicolon is shown in Figure 3.2, and a comprehensive list of quizzes and items are provided in Appendix Three at the end of this dissertation.

Figure 3.2

Sample Quiz Item



3.5.4 Datamining

At the end of the semester, data was mined from the collaborative note-taking Google Docs for each group in order to analyze how members collaborated. Specifically, the number of writing sessions each member engaged in and the number of edits each group member made to the writing of coworkers were calculated using DocuViz, a free, open-source Google Chrome add-on (see Wang et al., 2015). The volume of words contributed and the number of turns taken by each group member were calculated using a customized computer system called Collab_notetaking, which was developed for the present study. More information about this software can be found in

"Section 3.7: Custom Software Tools for Quantitative Data Collection" of this dissertation.

3.6 Quantitative Measures

In this section, each of the quantitative variables of the study are defined and described in terms of collection and analysis.

3.6.1 Completeness

In order to measure the quality of the storage that groups produced when taking notes collaboratively, the *completeness* of the notes was evaluated. Once the semester was finished, the notes taken by the groups were assessed in terms of the number of meaningful concepts that were represented from the online lecture videos for each week of the semester. This assessment was performed by using a rubric (Appendix B) created based on instructor-generated summaries of the information contained in the online lecture videos. To create this rubric, I first wrote my own summaries of the content of each lecture video for the course and divided up the contents of these summaries into meaningful phrases or sentences that were represented on the completeness rubric. These phrases and sentences were deemed to be meaningful when they contained information relevant to the topic of the video. Each of these meaningful phrases or sentences, hereafter referred to as "meaningful units", were given a unique code to indicate which instructional week and video they corresponded to, as well as a final number to indicate the meaningful unit's sequential position within the video. The meaningful units of content from each lecture in a given instructional week were represented sequentially, and the teaching assistants for the course assessed each note-taking document as having "represented" or "not represented" each unit of information from the lectures, with scores of "1" and "0" being assessed in these respective cases. The documents were scored using the completeness rubric, and the scores provided the completeness variable. The completeness rubric can be seen in Appendix Two of this dissertation.

3.6.2 Volume

The *volume* variable in the present study provided a measure of collaborative encoding and was calculated by counting the total number of words contributed by all constituent members of a group to a set of notes after all editing was completed. As note-taking is a relatively informal type of writing, contributions often took the form of a collection of short phrases. This made it impractical to calculate contribution at the sentence or paragraph level, so the word count added to the final document was deemed a logical unit of measurement of the contribution to the notes. The number of words was counted by using the "word count" feature of Google Docs and with supplementary programming in Python computer language. More information about the development of this software tool and its validity can be found in "Section 3.7: Custom Software Tools for Quantitative Data Collection" of this dissertation. The volume was assessed for each member of a group to obtain a between-persons variable, and the volumes contributed by each member were summed to obtain a between-groups variable.

3.6.3 Writing sessions

The total number of instances in which constituent group members logged into a note-taking document in order to contribute notes provided the *writing sessions* variable, which represented the extent to which learners sustained their collaborative encoding. To extract this variable, DocuViz, a data visualization tool for Google Docs, was used. For more information about the development and reliability of this tool, see Wang et al., 2015. The number of instances of logging into the document in order to contribute writing was counted for each group member to obtain a between-persons variable, and this variable was summed in order to obtain a between-groups variable. Along the top of Figure 3.2, the writing sessions of each constituent group member are represented by DocuViz as colored boxes with login dates and times listed above them.

3.6.4 Turn-taking

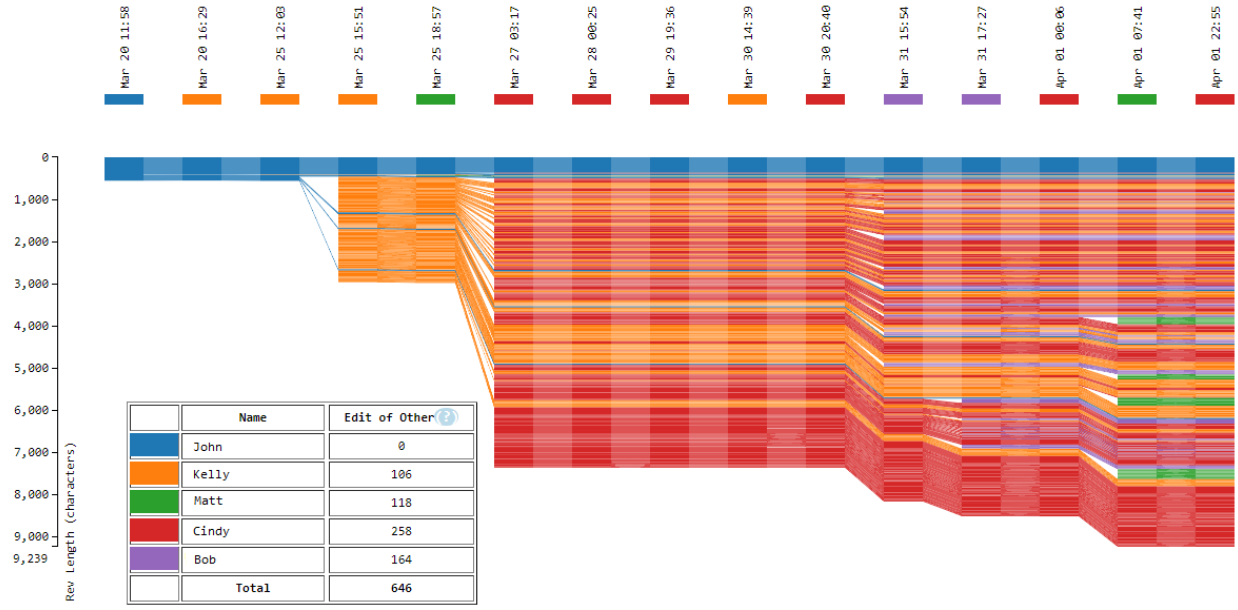
The *turns* variable in the present study was defined as an uninterrupted string of characters contributed by a constituent group member within a given set of notes. Therefore, a turn was counted for each instance in which a group member interleaved his/her text with the text of another group mate. More frequent instances of interleaving text among group members indicated higher levels of interaction among them, while less frequent instances indicated lower levels of interaction within the writing process. In order to calculate the turns variable automatically, a customized computer system was developed called Collab_Notetaking (https://github.com/porkchop-jim/Collab_Notetaking). More information about this customized computer system and its reliability is given in "Section 3.7 Custom Software Tools for Quantitative Data Collection" of this dissertation. The number of turns was calculated for each group member in order to obtain a between-persons variable, and the variable was also summed to obtain a between-group variable.

3.6.5 Edits of others

The *edits of others* variable represented the extent to which group members participated in the active revision of the writing of their fellow group members. This measure of collaborative encoding was obtained by calculating the total number of characters that a given group member inserted into and/or deleted from the writing contributed by his/her group mates. Once again, the DocuViz add-on was utilized to calculate the number of edited characters by each group member, as shown in Figure 3.3. For more information about the development and reliability of this tool, see Wang et al., 2015. The number of edited characters by each member of the group was used to obtain a between-persons variable, and this variable was summed in order to obtain a between-groups variable.

Figure 3.3

DocuViz Visualization of Student Notes



3.6.6 Quiz scores

The course examined in the present study included a total of 10 multiple-choice quizzes that were taken online on the course learning management system, and each quiz corresponded to 1 of the 10 total instructional weeks during the semester. The purpose of these quizzes was to measure learners' ability to recall and comprehend the information contained in each of the video lectures. Each quiz consisted of between 8 and 30 multiple-choice items that were based on the information from the online lecture videos from the corresponding instructional week. Learners were given only one attempt to take each quiz, and the quizzes were timed, allowing two minutes per item. Students were permitted to take the quizzes at their leisure during the instructional week, but were given a completion deadline of Friday 6 pm at the end of a given instructional week. Each quiz item allowed a student to choose more than one answer option, and partial credit was awarded when fewer than the total number of correct answer options were selected. However, when an incorrect

answer option was selected, the entire item was marked as incorrect, and no credit was awarded. This was done in order to discourage indiscriminate guessing on items where learners lacked knowledge of lecture content. Each of the 10 quizzes was weighted equally, accounting for 3% of a learner's total grade points for the course, so that quizzes accounted for a total of 30% of a learner's total score in the course. Cronbach's (1951) alpha coefficients for the quiz scores for each week were = .68, .62, .60, .69, .81, .64, .78, .58, .65, and .85, respectively, which suggests that the quizzes are a moderately reliable measurement of the instructional content of each week. For more details of each quiz item and the relationship to the instructional content, see Appendices One and Two, respectively labeled "Video List" and "Quiz Items" at the end of this dissertation.

3.7 Custom Software Tools for Quantitative Data Collection

The present study resulted in the creation of two customized computer systems that were respectively described in two manuscripts published in the proceedings of computer science conferences. These two computer systems are provided as freeware to the public in order to assist practitioners in implementing collaborative note-taking in their own courses and to help educational researchers analyze the nature of the collaborative processes students engage in when constructing their notes.

3.7.1 Collab_Notetaking: A customized computer system to automatically count turns

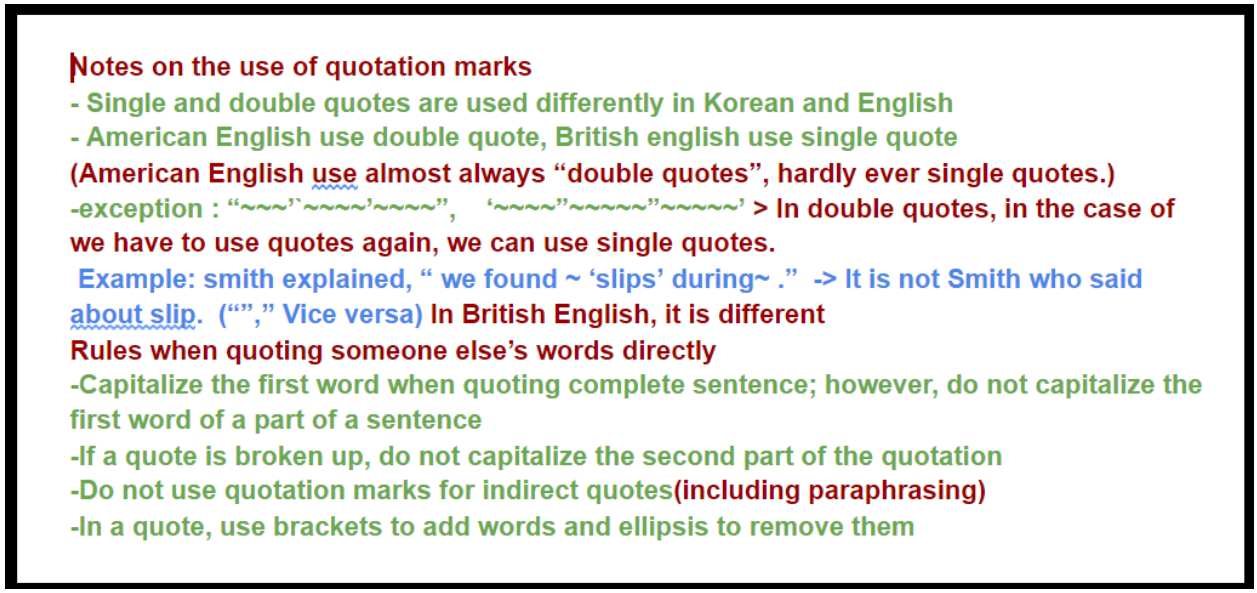
Taking turns is an important facet of collaboration. The number of turns taken can signify the degree to which learners interact when communicating or collaborating. (McKinlay et al., 1993). Most studies within the literature have focused on speaking rather than writing with respect to turn-taking. Within conversational contexts, turns taken in a conversation can be identified, as one speaker should speak at a time in a non-overlapping manner (Sacks, 1992). However, defining turns in the context of online documents is more challenging because contribution can occur in a free-for-all fashion (Gibson, 2009). Multiple

written contributions may be added to the document at the same time, and some contributions made by multiple authors can seem to meld together. Due to this lack of discreteness between turns, to the best of my knowledge, the first and only attempt to operationally define turns within the context of shared online documents was made my coauthor and I as part of the present dissertation research project (Fanguy & Chang, 2021). We freely provide a customized computer system to the practitioners and researchers that can automatically count turns using this definition. This operational definition and software enable researchers to measure the degree of interaction occurring among collaborative group members when writing within shared online documents. Such data may be useful to instructors who seek to facilitate high levels of interaction during collaborative writing activities.

The definition of turns we proposed was as follows: an interrupted string of characters written by a member of a group within a shared online document that fellow group members are able to read, alter, and respond to. To operationalize this definition, one would need to count the number of instances in which one group member's text was interleaved with the text contributed by other group members. This definition solves a problem in that it enables one to distinguish turns that are taken simultaneously or that meld together by simply counting the number of authorship changes within a given text. More frequent instances of interleaved text among authors signifies a higher degree of interaction among members in their writing process, while a lower number of instances signifies less interaction. Figure 3.4 shows a screenshot of a set of collaborative notes created using Google Docs. Each group member used a distinguishing font color (green, brown, and blue) to highlight their own contribution to the notes. Using the proposed definition, ten turns were taken in total by the members of the group in the figure below.

Figure 3.4

Sample Notes Taken by Three Students, Each Choosing a Distinguished Font Color



Because manual counting of turns is a laborious task, we developed a turn-counting computer system called Collab_Notetaking that saves a large number of Google Docs from Google Drive in order to provide a word count and the number of turns taken by each contributor. Collab_Notetaking populates this data into a local database and calculates the word count for each contributor. In order to distinguish the writing of each group member, learners were asked to select a unique font color other than the color black, which was the color used by the instructor for any instructions and formatting within the template documents.

3.7.1.1 Architecture of the Collab_Notetaking turn-counting system

Collab_Notetaking was created using Python programming language and utilizes a variety of publicly-available Python libraries. The system contains the following files: collabo_db.py, g_drive_list_folders.py, student_revisions.py, and font_counter.py.

When using Collab_Notetaking, the user runs collabo_db.py in order to generate a database named collabo.db. The user permits the system to interact with the Google Drive API via Google's security setup procedure and to receive Google's Client ID and the credentials.json json (JSON, JavaScript Object Notation) file. The credentials.json file must be kept in the same folder as the font_counter.py file. The user must also find the ID of the parent folder by running the g_drive_list_folders.py file. The folder ID can be found from the output. The user must put the ID of the folder into the font_counter.py file where stated.

When first running the font_counter.py, the web browser will open for authentication purposes. Two files for authentication will be created to circumvent the need for subsequent authentications. After completing this authentication procedure, the system searches within folders in order to download all Google Docs as MS Word document files (.docx) so that their formatting is maintained. After this downloading is complete, the system reads each file, counting the number of instances of authorship changes within each document. These instances are tallied and serve as the turn-taking variable.

3.7.2 Collab_doc_maker: An automatic Google-Doc-making tool

There are numerous benefits to writing collaboratively online within shared online documents such as Google Docs. For example, when writing online, group members can contribute writing at any time and from any location, thereby facilitating collaboration opportunities [2]. Furthermore, these documents can be analyzed for learning analytics by educational researchers in order to investigate the collaborative processes that learners participate in when working together [3,4]. However, there are also important cognitive costs that must be paid by the learners when engaging in collaborative writing. One such cognitive cost is the need to create and share Google Docs when writing collaboratively. In order to prevent unnecessary cognitive costs to learners and instructors, my coauthor and I developed a custom computer tool called Collab_doc_maker to help instructors automatically create large numbers of Google Docs, organized within folders and subfolders and automatically shared with predetermined members of student groups (Chang & Fanguy, 2021).

3.7.2.1 Initial setup

The computer system comprises three files: create_files_and_folders.py, requirements.txt, and term_year_gmail_addresses.csv. These can be downloaded from a public repository on Github (https://github.com/porkchop-jim/Collab_doc_maker).

Note that the following instructions are intended for Windows operating systems, as other systems will have slightly different methods for implementing and utilizing Collab_doc_maker. First, the user should install the required libraries by opening Command Prompt by typing “cmd” in the search box on the taskbar. Using the Command Prompt, the user must navigate to the location of the three aforementioned files. Once in the appropriate folder, the user must type the following command to install the required libraries: pip install -r requirements.txt.

3.7.2.2 Granting permissions

Prior to running the system, go to console.cloud.google.com to enable system permissions to access the Google Drive and Google Docs. Login and Create Project. Select Project once the Project is created. Select APIs & Services from the side bar menu and choose the OAuth consent screen on the sub-menu. Fill out all of the required fields, which are marked with red stars. The user must add his/her Gmail address to the Test users. In APIs & Services, select Library. Two libraries must be enabled: Google Drive API and Google Docs API. Next, go to the Credentials tab, click +CREATE CREDENTIALS, and select OAuth client ID. For the Application type, select Desktop app. Go back to the Credentials tab and download the file that has been newly created below the OAuth 2.0 Client IDs. The filename of this file is client_secret_XXXX.json. Rename the file to client_secrets.json and move it to the same directory as the create_files_and_folders.py file.

Run the create_files_and_folders.py by typing the following commands into the Command Prompt: python create_files_and_folders.py. Doing so will cause Chrome to open to allow the user to log in. The user should select

Continue on the screen which reads “Google hasn’t verified this app.” The user must then select Allow on the screen which reads “Grant ‘Name of App’ permission” screen. The user must select Allow on the screen that reads “Confirm your choices.” A file named google_credentials.txt is created within the same directory. The user must grant permissions for the Google Drive API and the Google Doc API. This process will be repeated once.

3.7.2.3 Document templates

The user must create a templates folder within their Google Drive. The user should create a unique name for the folders so that the system does not confuse one folder for another with an identical name. The user should create template Google Docs within this templates folder.

3.7.2.4 Providing access to students

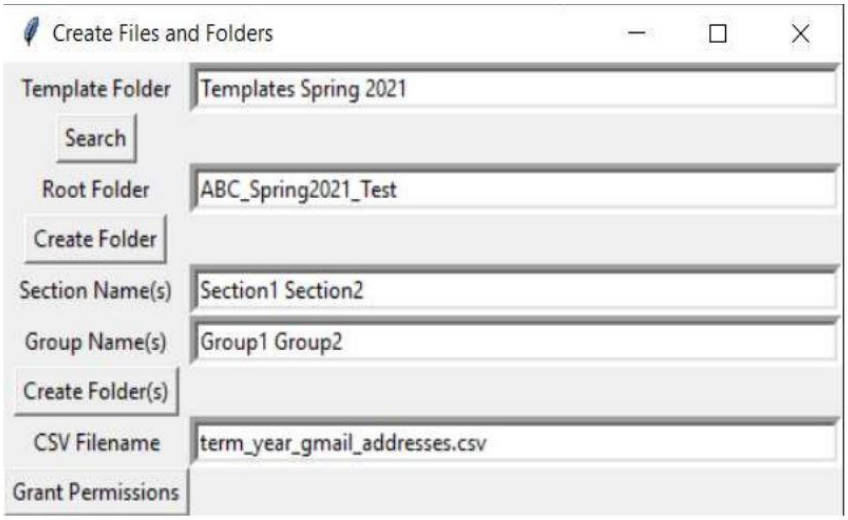
To enable students to access the documents, the user must add students’ names, Gmail addresses, course sections, and group numbers to the following database: term_year_gmail_addresses.csv.

3.7.2.5 Running the system

The user may now run the computer system. A window will pop up and prompt the user to locate a uniquely named template folder from the search bar, as shown in Figure 3.5. The number of documents will be shown below the search field. The user creates a root folder by typing in a name for the folder (spaces permitted). The folder ID will be shown below the root folder field. Importantly, the course section number and group names should not contain any spaces in the individual names (e.g. Section4 not Section 4). The number of course sections and groups should be separated by spaces (e.g. Section4 Group2). Once naming is completed, the user should create folders. The user should enter the name of the csv file in the field in order to permit students to access the documents. The system will read the file and grant permission at the level of the group folder.

Figure 3.5

Graphic User Interface with All Fields Filled out with Sample Text



Note that when using the system, the user could exceed rate limits imposed by Google in cases where the number of documents created along with the number of instances of permission granted to students exceeds a certain threshold over a given period of time. The user can avoid this issue by changing his/her usage limits in the API console (console.cloud.google.com). Also note that charges may apply when usage limits are increased.

3.8 Creation of the Quantitative Dataset

Data was collected 357 subjects in 17 sections of the Scientific Writing course offered during four semesters: four course sections in Spring 2019, three course sections in Fall 2019, six course sections in Spring 2020, and four course sections in Fall 2020. There was an average of 21 students in each of the 17 course sections At the end of each of the four semesters of the data collection period, a spreadsheet was created from each of the sections of the scientific writing course examined in the present study. The spreadsheets contained student learning data, including their scores for attendance, note-taking, and quizzes. These spreadsheets were then combined into a larger primary spreadsheet containing all of this data for all sections of each semester of data collection.

Next, the Google Docs that students used for taking collaborative notes during the semester were analyzed using DocuViz, a Google Chrome add-on for Google Docs, in order to measure the edits of others and number of writing sessions. A custom computer system written in the Python language was used to obtain the volume and turn-taking variables. These data were populated into a separate “collaborative data” spreadsheet for each semester using custom software. Then, the data were visually scanned for inaccuracies by comparing note-taking participation scores and total volume. A small sample (~5%) of note-taking documents were then further checked for inaccuracies, by hand-counting turns and comparing those numbers against values entered by the computer system. Once the data from this collaborative data spreadsheet were checked and confirmed to be valid, the data were added to the primary spreadsheet.

Lastly, the completeness of each note-taking document during each semester was evaluated by three teaching assistants (TAs). A total of 810 documents were evaluated for completeness, as there were 81 groups and a total of 10 note-taking documents per group, corresponding to the 10 instructional weeks of the course. To evaluate the completeness of the notes, TAs used rubrics based on instructor-generated summaries of the information contained in the online lecture videos for each of the ten instructional weeks of the semester. The informational units contained in each lecture for a given week were represented in sequence in the rubric, and the graduate teaching assistant for the course evaluated each set of collaborative notes as having “included” or “not included” each informational unit from the lecture. Each document was triple rated by three teaching assistants for the course. The course instructor held ten weekly norming sessions on Zoom with five teaching assistants. These meetings generally lasted from 1 to 1.5 hours. During these meetings, the course instructor discussed the rubric with the TAs. The instructor and the TAs then rated one sample set of notes together, discussing marks for each item represented on the rubric. After discussing and rating one example all together at the same time, the TAs were asked to rate another sample set of notes on their own and then reassemble with the instructor to discuss any differences among their scores. Once these differences were discussed, TAs

were given three samples of collaborative notes and asked to score them on their own. After this was done, the instructor and TAs reassembled on Zoom and checked the similarities of their scores, discussing any differences. Next, each of the five trained TAs was assigned to rate a proportion of the total number of collaborative notes students produced for the given instructional week.

The documents were assigned so that each document was rated by three teaching assistants in order to measure the reliability of their completeness ratings. The completeness ratings from each of the TAs was then gathered and Chronbach's Alpha was calculated for each week. The following values were obtained, and grading reliability among TAs was found to be generally high at α=0.88 (100 items, I), 0.95 (84 I), 0.86 (63 I), 0.94 (77 I), 0.80 (35 I), 0.84 (53 I), 0.87 (41 I), 0.88 (51 I), 0.97 (168 I), and 0.98 (258 I), respectively, with item-total(rest) correlations positive for all items for all 10 assessments (CTT package's reliability function; Willse & Shu, 2018). All meaningful units represented within the rubric can be seen in Appendix Two of this dissertation. The completeness data was added to the primary spreadsheet, and the primary spreadsheets for all semesters were combined into a master spreadsheet for all four semesters of the study.

3.9 Quantitative Statistical Analysis

Multi-level statistical modeling (Goldstein, 1987) offers a helpful framework for analyzing data derived from collaborative learning projects such as collaborative note-taking, the learning strategy examined in the present study. Multi-level modeling is useful in such cases because of the complexity of the data, which involves several nested hierarchies (Courtney et al., 2022). For instance, the weekly variance of a given learner's writing sessions contributes to a mean number of writing sessions for each learner. Additionally, individual variance in the average number of writing sessions for each learner contributes to an average number of writing sessions for that learner's group.

All statistical analysis for the present study was conducted using the open-source R programming language (R Core Team, 2022). The descriptive

statistics for each of the six quantitative variables collected in the present study included estimates of intraclass correlations (ICCs). In this case, the ICCs reflected the respective proportion of variance in the variables that can be attributed to between-group effects. As the completeness variable varied for each group, the ICC statistic was not relevant as no variation in completeness existed within groups. However, the completeness variable was modeled in the regression-based analysis as a between-group level variable.

3.10 Qualitative Data Collection

In contrast to quantitative research, qualitative research does not utilize statistical analysis or measurement techniques in the collection of data (Strauss & Corbin, 1990). Instead, qualitative research focuses on interpretations or descriptions of the feelings and phenomena people experience and how these phenomena occur (Johnson & Onwuebuzie, 2004). In the present study, the perceptions and feelings of students who participated in collaborative note-taking groups were recorded and used to triangulate the quantitative data that were collected. These student responses served as the qualitative component of an explanatory sequential mixed-methods research design. Among the four types of qualitative data collection, i.e., audio-visual materials, observations, interviews and surveys, and documents (Creswell, 2012), the present study utilized interviews. Interviews enable the investigation of phenomena, such as the feelings and perceptions of participants, which cannot be easily assessed through other methods; moreover, interviews enable the researcher to ask for additional information or clarification when unclear answers are given. Among the different types of interviews, i.e., one-on-one, focus groups, email, and telephone (Creswell, 2012), the present study utilized one-on-one interviews. One-on-one interviews can be conducted in a structured, semi-structured, or unstructured format (Schmidt, 2004), and the present study utilized semi-structured interviews to provide additional context and information to the quantitative data that was collected in addressing the research questions. Specifically, semi-structured interviews were conducted in order to ask students about their perceptions of collaborative note-taking as a learning practice and to

better understand the collaborative processes that they engaged in with their group mates when constructing their notes.

3.10.1 Semi-structured interviews

Following the completion of the Fall 2020 semester, 17 students who had taken the course were invited by the course instructor via email to participate in 20 to 30 minute semi-structured interviews on their experiences with collaborative note-taking during the Fall 2020 semester. As part of the ethical procedures approved for this study, students were informed of their rights to refrain from participating in the interviews, and 13 students agreed to participate while 4 refused. The interviews with 13 students were conducted by me, the course instructor, via Zoom due to the COVID-19 pandemic. Among the 13 participants, 9 were male and 4 were female, with ages ranging from 23 to 37 and an average age of 27.62. There were a total of 9 master's students and 4 doctoral students, with a wide variety of majors represented including Cultural Technology (3), Artificial Intelligence (2), Computer Science (1), Nuclear and Quantum Engineering (1), Global Information & Telecommunication Technology (1), Bio and Brain Engineering (1), Biological Sciences (1), Chemical and Biomolecular Engineering (2), and Materials Science and Engineering (1). A total of 6 participants were of Korean nationality, and 7 were of non-Korean nationality. The reason for the relatively high proportion of foreign participants in the interviews was that Korean students showed a higher propensity to decline to be interviewed. Perhaps foreign students felt more comfortable to be interviewed by a non-Korean interviewer (me) than did their Korean counterparts. In any case, the participant sample was fairly diverse so that a wide range of perspectives and experiences could be shared.

A list of semi-structured interview questions used in the present research is given in Appendix Four. In a semi-structured interview, the researcher draws up a set of questions beforehand, but these questions can be adapted or changed according to the natural flow of the discussion (Schmidt, 2014). The researcher can improvise or provide additional explanation with regard to the prepared interview questions, freely straying from these questions during the

process of the interview (Stringer, 2004). Semi-structured interviews were used in the present study to investigate students' perceptions of collaborative note-taking as a learning practice and to better understand the collaborative processes that they engaged in with their group mates when constructing their notes. Audio and video of the interviews were recorded and these were later transcribed for further thematic analysis, which is a common approach in qualitative research (Braun & Clarke, 2006).

3.11 Ethics

In order to conduct the present study, approvals from institutional review boards (IRBs) were applied for and granted by both the institution where the study was conducted (KAIST) and the institution where I am currently a PhD student (Lancaster University). As part of the process of receiving IRB approval from KAIST, I twice completed the certification course for Social & Behavioral Research provided by the CITI (Collaborative Institutional Training Initiative) Program. The risk of harm to participants was assessed as acceptably low by the IRBs of both KAIST and Lancaster; however, in the sections that follow, I will detail some of the key ethical concerns and consideration that were addressed during the IRB application process.

3.11.1 Ethical considerations related to the collection of quantitative data

All participants of the study were recruited from the sections of Scientific Writing that I taught during the four semesters of 2019 and 2020. A key ethical consideration in the present study, which was noted in my applications for ethics approval from both institutions, was the power relationship between myself and the participants of the research. As all participants were students in my course, the potential existed for students to feel pressured into participating in the research. During the course, I provided students with an electronic consent form informing them about the study I was conducting and of the types of data I intended to collect. The electronic form, rather than a paper form, was

used in order to avoid pressuring students into participating in the study. This way, students could indicate their participation status privately online without being identified, and could change their status at any time privately. The consent form clearly stated that students were free to participate or not on a voluntary basis and that all students who volunteered would be allowed to participate. Moreover, the form went on to assure students that their privacy and confidentiality would be protected, and that the contents of their intellectual property (most especially, their research writing) would never be disclosed to members outside of the research team. The form informed students that they had the right to withdraw their participation in the study at any time simply by informing me or by changing their status on the electronic consent form. Lastly, the form assured students that their participation or not would have no bearing on their course grades. Before presenting students with access to this electronic consent form, I carefully explained these important matters of consent verbally and answered any questions students had.

I believe that the risk of psychological or social harm was relatively low with the participants in this study as they were all graduate students, who are generally older and more experienced with research than their undergraduate counterparts. Their familiarity with research involving human subjects probably made them more likely to participate in the study. Furthermore, given the rather large number of participants, there is little likelihood of subject identification through these data. As mentioned earlier, as the course was given in Pass/Fail grading style, students' grade point averages were unaffected by their participation status.

In order to protect students' privacy, their collaborative notes were stored in a dedicated Google Drive account that I created for this research project. The account is password protected and further protected with 2FA. I will store these notes indefinitely, as they are a valuable learning resource that students may want to access in the future. Students' collaborative behavior data and notetaking completeness data are stored on my personal computer in my personal office, which is locked and accessible only to me. Students' learning data is stored on the university's Learning Management System and on the course's Turnitin site, where writing assignments were turned in by students

and evaluated by me. Audio recordings of interviews were removed from the recording device on the same day that they were created and were stored on my password-protected personal computer in my locked office. I will securely store the data for at least 10 years, as specified by Lancaster University.

3.11.2 Ethical considerations related to the collection of qualitative data

After grades were given, 17 students were invited via email to participate in semi-structured interviews regarding their experiences with collaborative note-taking during the semester. Among these, 13 agreed, and these interviews were conducted on Zoom and were recorded and transcribed. Students were again informed of the right to participate (or not) in these interviews and were asked for their permission to have their responses recorded and used in this research project. Unlike in the qualitative data collection stage, students who were invited to the qualitative data collection stage were unable to anonymously indicate their intention to participate in the study or not, as their email responses were not anonymous. To minimize pressure students might feel to participate as a result of the power dynamic existing between instructors and students, the email invitations for the semi-structured interviews were sent out nearly two months after the conclusion of the course. This time period was selected because final grades had already been given for the course so that students were well aware that their participation in the interviews would have no effects on their grades.

Chapter 4: Results

The purpose of the present study was to analyze how encoding affects storage, how encoding affects learning performance, and how storage affects learning performance in the context of collaborative note-taking. To do so, quantitative data was collected, and a correlational research approach was utilized to analyze relationships among collaborative encoding variables, the completeness of notes, and the subsequent quiz scores. This quantitative research approach was followed by qualitative data collection in the form of semi-structured interviews that I conducted from 13 student participants in the study regarding their experiences with collaborative note-taking during the semester. These qualitative data were collected in order to validate and contextualize the quantitative findings, providing triangulation for the results. In the explanatory sequential research design used in the present research, the research questions are primarily addressed through the analysis of quantitative data, with qualitative data used as a supplement to provide context and color. Therefore, this chapter will focus on the analysis of quantitative data, and relevant qualitative data in the form of interview quotes and responses are provided in “Chapter 5: Discussion”.

4.1 Description of Measures

In order to assess the collaborative encoding behaviors that groups and their constituent members engaged in when creating their notes, the following collaborative encoding variables were measured and analyzed at both the individual and group levels: volume of words contributed, number of writing sessions, number of turns taken, and amount of edits made to the writing of other members. The scores students received on weekly online quizzes provide the measure of learning performance for the present study. All averages are calculated across all ten weeks; for example, each of the 357 participants wrote a certain volume of words for week 1. The mean individual volume across all weeks is shown in Table 4.1 below. In order to assess the quality of the storage that groups produced when creating their notes, the completeness of the notes was evaluated using a rubric created by the course instructor. Because completeness varied at the group level, completeness was analyzed at the group

level only, and each constituent group member was assigned with the same completeness value each week.

Table 4.1

Descriptive Statistics for Measures of Collaborative Note-taking (n=357)

Variable	*M*	*SD*	Min	Max	Descriptor
Volume[1]	257.75	106.99	54	775	Total words contributed by each individual member per week
Writing Sessions[1]	1.84	1.25	0	12	Total number of writing sessions taken per group per week
Turn-taking[1]	7.04	7.47	0	53.75	The number of times the author changed within the document per group per week
Edits of Others[1]	461.08	1140.47	0	2,394	The amount of keystrokes students make over another's writing per individual member per week
Completeness of notes[2]	77.21	54.73	19	252	Total concepts represented per group per week
Quiz Scores[1]	2.07	0.54	0	3	Mean quiz score per group per week

Note. Descriptive statistics given for all possible values across all weeks (grand means); [1]values in variable vary each week individually; [2]value in variable varies each week by group only.

4.2 Descriptive Statistics for Measures of Collaborative Note-taking

As shown in Table 4.1, individual group members contributed an average volume of 257.75 words each week to the collaborative notes, with a standard deviation of 106.99, a minimum of 54 and a maximum of 775 words. Individuals contributed this volume by engaging in an average of 1.84 writing sessions each week, with a standard deviation of 1.25, a minimum of 0, and a maximum of 12

sessions. Individual group members took 7.04 turns per week when creating the collaborative notes, with a standard deviation of 7.47, a minimum of 0 and a maximum of 53.75 turns. Individual group members made 461 keystrokes of edits to the writing of their peers on average per week, with a standard deviation of 1140.47, a minimum of 0, and a maximum of 2394 keystrokes. As previously mentioned, completeness varied at the group level, so Table 4.1 shows that groups represented an average of 77.21 concepts from the lectures they watched online each week, with a standard deviation of 54.73, a minimum of 19, and a maximum of 252 concepts. On average, individual group members received a score of 2.07 out of 3 on weekly quiz scores, with a standard deviation of 0.54, a minimum of 0, and a maximum of 3 points.

4.3 Intraclass Correlation Coefficients for Collaborative Note-taking Variables

Table 4.2 presents the intraclass correlation coefficients for all of the variables measured in the present study at the group (between groups) and individual (between persons) level. These intraclass coefficients indicate the extent to which the means vary at the group and individual levels, respectively, with values closer to 1 indicating higher levels of variance and values closer to 0 indicating lower levels of variance. As shown in the table, at the group level, the intraclass coefficient for completeness is relatively low at 0.023. In the case of quiz scores, the intraclass coefficient is low at the group level at 0.079, but relatively higher at the individual level at 0.159, which indicates relatively higher levels of variance of quiz scores at the level of the individual. A similar pattern occurs for all of the collaborative encoding variables measured in the present study. In the case of volume, the intraclass coefficient is relatively low at the group level of analysis at 0.044, but considerably higher at 0.278 at the individual level of analysis. For edits of others, the intraclass coefficient is 0.030 at the group level, and 0.153 at the individual level. For writing sessions, the intraclass coefficient is 0.073 at the group level of analysis and 0.249 at the individual level

of analysis. For turn-taking, the intraclass coefficient is 0.401 at the group level of analysis, and 0.131 at the level of the individual.

Table 4.2

Intraclass Correlation Coefficients for Collaborative Note-taking Variables

ICC	Completeness of notes	Quiz Scores	Volume	Sessions	Turn-taking	Edit of Other
Between Groups	0.023	0.079	0.044	0.073	0.401	0.030
Between Persons		0.159	0.278	0.249	0.131	0.153
Note. ICC = intraclass correlation.						

4.4 Statistical Correlations

All other results for Hypotheses 1 to 4 are presented in Tables 4.3 and 4.4. More specifically, Table 4.3 presents correlations between all variables at the level of the individual, i.e., between persons, and Table 4.4 presents correlations between all variables at the level of the group, i.e. between groups.

4.4.1 Individual-level Correlations

As shown in Table 4.3, the collaborative encoding variables of volume, turn-taking, and edits of others all correlate positively with quiz scores, while only writing sessions do not correlate with quiz scores at the individual level. Specifically, at the individual level, volume shows a significant positive correlation of 0.075 with quiz scores, so the null hypothesis is rejected for Hypothesis 1a. Writing sessions, at the level of the individual, show a correlation of 0.032 with quiz scores, which is not significant, so the null hypothesis for Hypothesis 1b is accepted. Turn-taking, at the individual level, shows a significant positive correlation with quiz scores, so the null hypothesis is rejected for Hypothesis 1c.

Edits of others, at the individual level, show a significant positive correlation of 0.028 with quiz scores, so the null hypothesis is rejected for Hypothesis 1d.

Table 4.3

Between Persons Correlation Matrix

Variable	Completeness of Notes	Quiz Scores	Volume	Edits of Others	Sessions	Turn-taking
Completeness of Notes						
Quiz Scores		1				
Volume		**0.075*** **	1			
Edits of Others		**0.028***	**0.088*** **	1		
Sessions		0.032	**0.087*** **	0.005	1	
Turn-taking		**0.047*** **	**0.143*** **	**0.028***	**0.034***	1
Note. *$p < .05$, **$p < .01$, ***$p < .001$						

4.4.2 Group-level Correlations

As shown in Table 4.4, at the group level, among the collaborative encoding variables, only two show a significant statistical correlation with quiz scores: 1) edits of others shows a negative correlation with quiz scores, meaning that groups that showed a higher propensity to edit each other's work performed worse on quizzes than groups with a lower propensity to edit, and turn-taking shows a positive correlation with quiz scores, meaning that groups that took more turns when writing notes performed better on quizzes than those who took fewer turns. Specifically, at the group level, volume shows no significant correlation with quiz scores with a value of 0.007, so the null hypothesis is accepted for

Hypothesis 2a. For writing sessions, at the group level, no significant correlation was found with quiz scores with a value of 0.018, so the null hypothesis is accepted for Hypothesis 2b. For turn-taking, at the group level, a significant positive correlation of 0.073 was found with quiz scores, so the null hypothesis is rejected for Hypothesis 2c. For edits of others, at the group level, a significant negative correlation of -0.033 with quiz scores was found, so that the null hypothesis is accepted for Hypothesis 2d, and in fact, the opposite result was found.

Table 4.4 further shows the correlations between the collaborative encoding variables and completeness, with only volume and writing sessions showing a significant positive correlation with completeness. Specifically, volume, at the group level, was significantly and positively correlated with completeness with a value of 0.023, so the null hypothesis is rejected for Hypothesis 3a. Similarly, at the group level, sessions were found to significantly and positively correlate with completeness, so the null hypothesis is rejected for Hypothesis 3b. However, no correlation was found between turn-taking and quiz scores with a value of 0.021, so the null hypothesis is accepted for Hypothesis 3c. Similarly, no significant correlation was found between edits of others and quiz scores at the group level, so the null hypothesis is accepted for Hypothesis 3d. Finally, the completeness of notes was found to positively and significantly correlate with quiz scores at the group level with a value of 0.018, so the null hypothesis is rejected for Hypothesis 4.

Table 4.4

Between Groups Correlation Matrix

Variable	Completeness of notes	Quiz Scores	Volume	Edits of Others	Sessions	Turn-taking
Completeness of notes	1					
Quiz Scores	**0.018****	1				
Volume	**0.023*****	0.007	1			
Edits of Others	0.009	**-0.033***	0.013	1		
Sessions	**0.016***	0.018	0.023	0.000	1	
Turn-taking	0.021	**0.073***	0.038	-0.016	0.048	1
Note. *p < .05, **p <.01, ***p < .001.						

4.5 Results of the Research Hypotheses

The results from the correlational analysis suggest the following:

H1a: When students *produce a higher volume of words*, they perform better on quizzes. Reject null

H1b: When students *have more frequent writing sessions*, they perform better on quizzes. Accept null

H1c: When students *take more turns*, they perform better on quizzes. Reject null

H1d: When students *edit more of their group members' writing*, they perform better on quizzes. Reject null

H2a: When groups *produce a higher volume of words*, they perform better on quizzes. Accept null

H2b: When groups *have more frequent writing sessions*, they perform better on quizzes. Accept null

H2c: When groups *take more turns*, they perform better on quizzes. Reject null

H2d: When groups *edit more of their group members' writing*, they perform better on quizzes. Accept null (note opposite)

H3a: When groups *produce a higher volume of words*, the completeness of group notes improves. Reject null

H3b: When groups *have more frequent writing sessions*, the completeness of group notes improves. Reject null

H3c: When groups *take more turns*, the completeness of group notes improves. Accept null

H3d: When groups *edit more of their group members' writing*, the completeness of group notes improves. Accept null

H4: When groups have higher levels of completeness, they perform better on quizzes. Reject null

4.6 Summary of the Results

To summarize, the results at the individual (between-persons) level of analysis suggest that volume, edits of others, and turn-taking were associated with improved individual quiz scores. Results from the group (between group) level of analysis suggest that 1) turn-taking was associated with improved group quiz scores, 2) volume and sessions were both associated with improved group note-taking quality, and 3) note-taking quality was associated with improved group quiz scores. After the conclusion of the Fall 2020 semester, semi-structured interviews were conducted with 13 participants of the study. The purpose of these interviews was for contextualization and complementary triangulation of the quantitative results of the study. Relevant quotes and responses from these interviews will be provided in Chapter 5: Discussion to help provide a clearer picture of the quantitative findings of the study.

Chapter 5: Discussion

The results of the present study indicate that various types of collaborative encoding are associated with learning performance and completeness. Overall, the statistical correlations were relatively weak, particularly level of the group. This is perhaps due to the lack of variation in the collaborative writing behaviors and note-taking completeness of the groups, as described previously in the intra-class correlations in Table 4.2. However, there were somewhat higher correlations among variables at the individual level, as the behaviors of individuals varied somewhat more in creating collaborative notes. The nature of these effects depended on the variable being examined and on the level of analysis, and the present study yielded results which were nuanced and challenging to parse when mapping them onto the existing literature. In the subsections that follow, the effect of completeness on learning performance will be explained, and then each collaborative encoding variable will be discussed in terms of its effects on learning performance at the individual and group levels and on completeness at the group level. In order to contextualize the quantitative results of the study, the following discussion will also include qualitative data taken from the semi-structured interviews that were conducted with the participants at the conclusion of the course. Integration of this qualitative data into the discussion of the results will help to triangulate and thereby validate them.

5.1 The Effect of Storage Quality on Learning Performance

The literature on encoding and storage suggests that the notes that students produce provide a valuable supplement to the limited and imperfect memories of learners, and that this storage can be reviewed by students in preparation for exams (Di Vesta & Gray, 1972; Kiewra, 1989). The completeness of notes showed a significant positive correlation with group-level learning performance, so that Hypothesis 4 (see p. 104) was supported. This result also supports prior work analyzing data from the present dissertation project that suggests that completeness positively correlates with learning performance (Costley et al., 2022). The finding is also in line with prior work that posited that

more complete notes enable students to recall more information and to achieve higher scores on quizzes (Tindale & Winget, 2017), as well as research suggesting that when groups take more complete notes, they achieve higher levels of comprehension (Butson & Thomson, 2014).

Although a positive correlation was found between completeness and quiz scores, the effect was somewhat less than I expected. One explanation for this is that there could be a saturation point of completeness, after which further increases in the completeness of the notes yield diminishing benefits to learners' ability to recall information. In another study examining data from this dissertation project, my coauthors and I found that collaborative note-takers produced more complete notes and demonstrated better recall performance than those of individual note-takers, suggesting a strong relationship between completeness and learning performance. The same study also showed that completeness varied more among individual-note-takers than collaborative note-takers, as a substantial number of individual note-takers took incomplete notes (Courtney et al., 2022). In that paper, as in the present one, there was relatively low variation in the completeness of notes produced by collaborative note-taking, as collaborative note-takers generally composed highly complete notes. Such a lack of variability of completeness may have contributed to the relatively weak but significant positive correlation between completeness and learning performance in the present study. Further research is needed to tease out these effects.

Another possibility is that the positive correlation between completeness and learning performance was somewhat weakened due to the manner in which students utilize the storage when studying for quizzes or exams. The literature on encoding and storage implies that storage is useful to students because they are able to review their notes at a later time after a lecture is completed (Di Vesta & Gray, 1972; Mueller & Oppenheimer, 2014). However, in online courses, such as the one examined in the present study, lectures are often given in the form of prerecorded online videos that students can watch at their convenience on the learning management system. This valuable aspect of online learning, namely that online video lectures can be viewed on demand, could affect the manner in which storage affects learning performance, or more specifically, the way that learners use storage.

To this end, an interesting effect was noted in an interview with Student 4, who mentioned that he/she often utilized the storage provided by her group mates in an attempt to better understand the videos while he/she was viewing them:

> "These notes are more like subtitles, and these are at one place, so I can just completely go through the video and the notes side by side. And I can understand all of these things in one go. And then I can just re-read these notes. And so that it sticks to my mind." [S4].

He/she further explains that when notes taken by others were unavailable, he/she felt more strain to concentrate on writing notes while listening to the lecture:

> "So when I am writing the notes, like for the video…what happens is I just see the video multiple times. Like while writing the notes, I just pause the video multiple times because I don't want to miss something important and write what I have heard up till this point of time. Then I move forward. I cannot write in one go, so I have to write while pausing the video multiple times. So I think in that way…I sometimes miss the information that [was] written so far. I forget. And then after completing the entire video, I have to read the notes and then understand" [S4].

From this description, it seems that collaborative storage may be reviewed by learners in two ways when used in such online learning environments: 1) the traditional method of reviewing notes *after* viewing the lecture video and 2) as a guide or "subtitles" *while* actively listening to the lecture video. In the latter usage, the notes served the role of subtitles that could be viewed in a separate window from that of the lecture video.

Research results on the learning effects of viewing lecture videos with subtitles have been mixed. While a number of studies have shown benefits to learning outcomes when subtitles are used videos related to language learning (Markham, 1999; Perez et al., 2013; Winke et al., 2013), there is also a body of research indicating that viewing videos with subtitles is less effective than those

without when students were tested on their comprehension of the learning content (Harskamp et al., 2007; Kalyuga et al., 1999; Mayer et al., 2003; Mayer et al., 2001). One explanation for the findings showing that subtitles had a negative impact on learning performance was that the use of subtitles was found to increase learners' perceived levels of cognitive load, which in turn necessitated more re-watching of the videos (Kalyuga et al., 1999). One reason for this rise in perceived cognitive load could be that students are forced to split their attention between two windows on their computer screen, i.e., the window where the video is playing and the window showing the notes. When students are forced to split their visual attention between two sources of information at once, their working memories can become overwhelmed due to the high level of concentration and effort required by this task, a phenomenon known as the Split Attention Effect (Chandler & Sweller, 1992). When cognitive load is increased during a learning activity, fewer cognitive resources can be utilized to integrate information into the long-term memory, harming performance on recall based quizzes (Ginns, 2006; Sweller et al., 1998).

Therefore, it is possible that high levels of completeness in notes created a benefit for groups' learning performance when used in review sessions in preparation for online quizzes. However, some of the beneficial effects of completeness of notes on learning performance may have been dampened or washed out by the negative effects of increased cognitive load during viewing when using the notes as a set of subtitles for the video being viewed.

5.2 Volume as a Form of Collaborative Encoding

Volume is considered the primary measure of encoding in most of the literature on note-taking, as it involves the learner writing down concepts from a lecture in order to imprint this information into their long-term memory and to produce a written record of the concepts for future review sessions. For this reason, volume is generally viewed as the primary path through which students gain learning benefits when taking notes. In the present study, volume was found to positively impact storage as well as learning performance at the individual level, but had no effect on learning performance at the group level.

5.2.1 The effect of volume on storage quality

The first result is that volume was statistically and positively correlated with completeness. This result supports Hypothesis 3a (see p. 104) and suggests that volume is a key driver of storage quality. This result is also in line with prior studies in the literature showing that a larger volume of contribution during collaboration allows learners to generate a greater amount of knowledge on a given subject (Adeniran et al., 2019; Doberstein et al., 2019). Volume and completeness are each considered to be manifestations of the depth of learners' understanding of the learning content when taking notes (Adeniran et al., 2019), so it is reasonable to expect these variables to be correlated. Explained in the language of the collaborative encoding-storage paradigm, groups are better able to produce high-quality storage when they engage in more *productive* encoding behaviors, i.e. taking more voluminous notes.

From the perspective of collaboration, volume and completeness can have an important impact on group dynamics and trust. This effect may be further explained by examining a quote from the semi-structured interviews conducted at the end of the semester:

> "Well, if, for example, one of the five people did not take a note or…only two or three sentences, it is obviously bad notes. So in that case, we cannot trust them…but yeah, in our groups' case, everyone took the very best [notes]. So we can trust the other people in our group…" [S8]

Student 8 mentioned that his/her group mates gained each other's trust during the semester by taking a large volume of notes. Interestingly, once members realized they were in a group that produced a high volume of notes, they also increased their trust in the quality of the notes. This raises an important distinction in that, in the present study, note-taking quality was measured by a third party outside of the group (i.e., the researcher); however, it is entirely possible that groups had a different perception of the quality of the notes they were producing and that these perceptions could have been affected by group dynamics, including trust. Student 4's answer above suggests that, at least in the case of

one group, trust in the quality of the notes was enhanced through the contribution of more voluminous notes.

5.2.2 The individual-level effects of volume on learning performance

Volume had a significantly positive correlation with quiz scores at the individual level of analysis, supporting Hypothesis 1a (see p. 104). This result seems to contradict the findings of one study that found that, although constituent members of collaborative note-taking groups wrote more, on average, than their individual note-taking counterparts, there was no difference when their quiz scores were compared (Kam et al., 2005). Instead, the present result supports prior work that found that when individual learners took a higher volume of notes, they performed better on subsequent measures of learning performance (Haynes et al., 2015), specifically in terms of their ability to recall concepts from a lecture (Mueller & Oppenheimer, 2014; Oefinger & Peverly, 2020).

Along these lines, some of the students who participated in the semi-structured interviews at the end of the semester specifically mentioned that taking notes within a collaborative group caused them to write down a larger volume of notes on a given topic than they might have done if taking individual notes which would not be shared with a group. For example, Student 9 commented:

> “I think [the collaborative notes] have much, much more volume than the notes I [would have taken] by myself because it is for [all group members] to see it. So, yeah, I cannot just simply roughly write only for myself. I just have to detail some explanations for all” [S9].

This response suggests that learners may sometimes feel the need to write more voluminous notes in order to explain concepts clearly to their group mates. It is possible that in attempting to clearly explain concepts in the notes to their group mates, a learner gains a deeper understanding of the concepts that he/she is writing about, a well-documented effect known as peer instruction (Mazur, 1997). This more voluminous explanation also necessitates additional encoding, enabling the learner to imprint more information into the long-term memory and thereby improving learning performance.

5.2.3 The group-level effects of volume on learning performance

However, at the group level, there was no correlation between volume and learning performance, so that Hypothesis 2a (see p. 104) was unsupported. This means that, as mentioned above, individual learners who wrote more had better learning performance, but groups that produced more notes did not outperform groups who wrote fewer notes. When a learner takes notes, he/she encodes information into the long-term memory through the writing process. However, when notes are taken collaboratively, each member is only expected to take notes on a portion of the total lecture content since their group mates should write down information from other parts of the lecture. Consequently, the more notes that a student records, the more information that student can encode to long-term memory. This is why volume affects the learning performance of individual learners, as mentioned in the previous subsection. However, at group level, as note-taking responsibilities are divided up, so are the opportunities for encoding and the benefits they provide. This may have weakened the positive effect that volume was found to have on group-level learning performance in the present study to levels that did not amount to significant correlation.

5.3 Writing Sessions as a Form of Collaborative Encoding

While volume represents the principal pathway to encoding in the collaborative encoding-storage paradigm, writing sessions represent how sustained encoding behaviors are when creating collaborative notes. As students log in to the collaborative notes in order to contribute, they are presented with opportunities to collaboratively encode information from course lectures with their group mates. Furthermore, a higher number of sessions presents increased opportunities for them to consider and respond to one another's contributions to the notes, enabling them to create higher quality notes. In the present study, the number of writing sessions affected the quality of the storage that groups created but had no effect on their subsequent learning performance at either the individual or group level.

5.3.1 The effect of writing sessions on storage quality

In the present dissertation, the number of writing sessions showed a significant and positive effect on the storage quality of the notes created by the groups, so that Hypothesis 3b (see p. 104) was supported. This effect corresponds to prior work that found that more frequent sessions in online learning settings led to improved quality of interaction among learners, and resultantly, improvements to the quality of the discourse they created (Kent & Cukurova, 2020). According to research in CSCL, learners create group knowledge through their sustained interactions with one another, and this group knowledge can be represented by the digital artifacts they collaboratively create (Stahl et al., 2014), i.e., the collaborative notes in the present study. Thus, the present result indicates that a sustained approach to encoding lecture contents promotes the development of high-quality storage when taking collaborative notes.

5.3.2 The individual- and group-level effects of writing sessions on learning performance

On the other hand, the number of writing sessions was not found to affect learning performance at the individual level or group level of analysis in this study. Accordingly, neither Hypothesis 1b nor 2b (see p. 104) were supported. These findings, while unexpected, correspond somewhat to the results of a recent study that found that an increased number of sessions did not increase learning performance in and of itself unless the sessions involved substantial contributions of volume by the group members (Chai et al., 2020). However, the present results contradict the instructional approaches of CSCL, which suggest that students learn through continued interactions with each other and with course material (Kessler & Bikowski, 2010). The results of the present study further contradict the results of prior research that found that more frequent collaboration sessions during online learning improved individual learning outcomes (Jo et al., 2015; Manathunga & Hernandez-Leo, 2016). Interview responses obtained at the end of the semester, which will be shared in the next section, may shed some light on why this was the case.

5.3.3 Learners' strategic use of writing sessions in collaborative note-taking

While the literature suggests that learners create group knowledge through their sustained interactions (sessions) in the online learning environment (Google Docs containing the notes), groups in the present study often employed a more *cooperative* rather than *intensely collaborative* approach to note-taking, and this was described in a number of interview responses. These two approaches to group work differ in that cooperation is primarily focused on working together to produce a final product (storage), while successful collaboration involves learners participating in the process of creating knowledge (encoding) (Dillenbourg et al. 1996; Kozar, 2010; Roschelle & Teasley 1995). In the present study, rather than employing an intensely collaborative approach in which every group member contributing notes and responding to and interacting with the written contributions of their group members for every single video topic, members tended to employ a cooperative approach which they divided up their note-taking responsibilities, assigning each group member to take notes on particular videos, thereby saving time and work.

In other words, rather than every group member writing notes on every single video topic, groups tended to divide up note-taking responsibilities, assigning particular group members to take notes on particular videos, thereby saving time and work.

Student 6 described how, in his/her group, writing sessions were mainly done asynchronously, as group members checked in on the document at random intervals to make sure that the notes were completed before the quiz was due:

> "There were times when I would just [take notes on] like one or two videos because I didn't have more time. And then I would come back like one day or two days later, and the others already [took notes on] the other videos. I think we kind of always switched randomly, but it kind of worked that it was fair at the end" [S6].

This quote suggests that students often logged into the collaborative note-taking documents to check on the progress of their group mates on the note-taking tasks and to figure out where more notes were needed. These writing sessions were sometimes more about ensuring that the notes were complete and that labor was evenly divided among the members rather than about reading responses to their own contributions and responding to the contributions of other members. As such, more frequent writing sessions may have helped to ensure more complete notes, but may not have resulted in learners engaging in the type of lively back and forth interaction that results in deeper learning (Stahl et al., 2006)

5.4 Turn-taking as a Form of Collaborative Encoding

In the collaborative encoding-storage framework, turn-taking indicates the level of interactivity of a group's encoding process. In other words, turn-taking represents the extent to which group mates interact with and respond to each other's writing when constructing collaborative notes. In the present study, turn-taking was not correlated with the quality of the notes that group produced. However, turn-taking was significantly and positively correlated with learning performance at both the individual and group levels of analysis.

5.4.1 The effect of turn-taking on storage quality

Unexpectedly, turn-taking was found to have no effect on the completeness of the notes that groups took, so that Hypothesis 3c (see p. 104) was unsupported. This result contradicts research suggesting that when groups engage in more interactive processes of collaboration, where contributions garner reactions and responses from fellow group members, they are more effective in collaboratively constructing knowledge (Kessler & Bikowski, 2010). Research in CSCL has long argued that the co-construction of knowledge is the result of interaction within the group, i.e., the free flow of ideas and responses to those ideas (Stahl et al., 2006).

In a number of interviews conducted at the end of the semester, students explained that their groups had elected to employ a "divide and conquer" strategy when creating their notes. In such a strategy, students divided up the note-taking

responsibilities in a cooperative, rather than intensely collaborative, manner, such that each member would be solely responsible for taking notes on a given lecture video. As an example of this, Student 10 described his/her experiences with reviewing the collaborative storage the group produced as follows:

> "To tell the truth, it's very hard to write all of the notes by yourself because we don't have a lot of time because we're graduate students. We have other stuff to do, but by doing the collaborative note-taking, we can…divide the parts we need to work on. So it's very time-saving, and then, you can study the notes after the course, and you don't have to study all of it by yourself and you can just look at [notes]…by other people. So I think that's why it really helped me" [S10].

When asked to compare the completeness of the group notes to the notes the student would have usually taken on his/her own, the following response was given:

> "[The collaborative notes] would have been more complete because you can just concentrate on only one section instead of doing all of this stuff. So I think it's better. You can get more specific notes" [S10].

Such an approach would lead to fewer turns being taken, but may have resulted in more complete notes since each student was able to limit the focus of his/her note-taking to a smaller amount of lecture material. By limiting their focus in this way, more time, effort, and cognitive resources could be devoted to creating highly detailed and complete notes, an effect that was also noted with regard to writing sessions in "Section 5.3.3: Learners' strategic use of writing sessions in collaborative note-taking."

5.4.2 The individual- and group-level effects of turn-taking on learning performance

While encoding in a turn-based way had no impact on storage quality, it positively impacted learning performance, both at the individual and group levels,

so that both Hypotheses 2c and 3c (see p. 104) were supported. These results are in line with prior findings that learners benefit from interaction while taking notes collaboratively because their group mates can remind them of information they have forgotten from the lecture (Landay, 1999). Taken together with the lack of correlation with note-taking completeness, these turn-taking results indicate that the value of turn-taking when taking collaborative notes is that it is a successful way to encode learning content into the long-term memory, but that it does not affect the co-construction of group knowledge (storage). In other words, highly interactive approaches do not lead groups to deeper knowledge or better ideas, but instead, interaction enables both individuals and groups to better recall instructional content they have been exposed to. Taken together, these findings indicate that when a group collaborates in order to create high-quality learning artifacts, cooperation is a more advantageous approach to group work, while if the objective of the group is to increase learning performance, collaboration is a more advantageous approach.

5.5 Edits of Others as a Form of Collaborative Encoding

The amount that students edit the work of their group mates implies the extent to which they engage in encoding the notes contributed by other members. The present results reveal that edits of others had no impact on the quality of storage produced by the groups, so that Hypothesis 3d (see p. 104) is unsupported. On the other hand, edits of others were found to positively impact learning performance at the individual level, but were found to negatively affect learning performance at the group level, so that Hypothesis 1d was supported but Hypothesis 2d (see p. 104) was contradicted. In other words, while individuals who engaged in more editing of the writing of their group mates performed better on quizzes than those who edited less, groups that showed a higher propensity to edit each other's work performed worse on quizzes than groups with a lower propensity to edit.

5.5.1 The effect of edits of others on storage quality

As was the case with turn-taking, in the present study, edits of others had no effect on the completeness of the notes that groups created, so that Hypothesis 3d (see p. 104) was unsupported. This result contradicts prior findings that suggest high levels of interaction and responsiveness, which take place when students read, reflect on, and revise each other's work, will lead to the construction of deeper levels of group knowledge (Kessler & Bikowski, 2010; Stahl et al., 2006). It further contradicts research on online collaborative writing showing that edits of others raises the quality of writing that students produce (Blau & Caspi, 2009). However, as shown previously with regard to turn-taking, it may be the case that cooperative approaches to note-taking yield more complete notes as compared to collaborative approaches, as the former enables each student to focus on particular parts of the instruction rather than spreading his/her cognitive resources thin by trying to record every point that was said in every lecture video. Meanwhile, collaboration itself poses serious cognitive costs to the learner, including management of group dynamics and social interaction, which will be discussed in greater detail in the next section.

5.5.2 The individual- and group-level effects of edits of others on learning performance

The results showed contrasting effects of edits of others at the individual and group levels. In the present study, the results suggest that when a student provides overt correction or rewrites parts of the notes written by other group mates, that type of collaborative encoding is beneficial to the "editor", but is harmful to the learning performance of the other group members. Prior work has shown that although edits of others can raise the quality of writing, group members themselves may view such editing as detrimental to the quality of the collaborative document (Blau & Caspi, 2009). Similarly, prior work has also shown that edits of others' writing can lead to conflicts within collaborative writing groups on large-scale collaborative platforms, such as Wikipedia (Birnholtz & Ibara, 2012). Moreover, disruption or confusion may occur when a learner edits a collaborative document, such as a Google Doc, without first consulting other group members, which can stymie further partition in the writing process (Birnholtz & Ibara, 2012; Halfaker et al., 2011). So while there appears to be

substantially beneficial encoding effects for an individual learner who edits the work of his/her group mates, this may not be an advisable approach at a group level because group members may view these edits to their writing and eventually the collaborative document itself as less reliable and of lower quality. In the case of collaborative note-taking, this may lead to groups choosing not to rely on the notes when studying for exams.

Student 7 pointed out his/her awareness of the dilemma posed by editing the work of others. He/she expressed a sense of caution or concern for the feelings of others when changing the text of other students, using Google Doc's suggesting mode to clearly distinguish changes made to the writing of group mates:

> "I just wrote whatever I think should be included… Honestly, for something that's for some other classes that I don't want to interrupt others' writing, I definitely use [suggesting mode] to just give some comments on some parts that need to be rewritten. Better quizzes require more information, so I just try to add it right away. I just added some text because the color is different, so they can just easily recognize who wrote it" [S7].

When we view the effects of edits of others and turn-taking together, which are the two encoding variables most related to the interactivity among members of a group, i.e., these two variables cannot occur without interaction among multiple group members, the present findings suggest that interaction is a vital component of collaborative encoding, but only to the extent that such interactions are additive, meaning that they result in the addition of new information, suggestions, or responses being written down (turn-taking), rather than subtractive, meaning that the writing of others is removed or replaced (edits of others).

Chapter 6: Conclusion

The present study has examined the educational experiences of 357 students participating in online collaborative note-taking in 17 different class sections of a graduate-level scientific writing course. The purpose of this study was to investigate the processes and products of collaborative note-taking and their respective effects on the subsequent learning performances of groups and their constituent members. To do so, the study proposed the collaborative encoding-storage paradigm as a theoretical framework that extends the traditional encoding-storage paradigm to include collaborative writing behaviors and processes used when taking notes collaboratively. Using the proposed framework, a correlational study was conducted that investigated how encoding affects storage, how encoding affects learning performance, and how storage affects learning performance in the context of collaborative note-taking. Data was mined from the notes that student groups produced in order to assess the extent to which they engaged in the following forms of collaborative encoding at the individual and group levels: volume, writing sessions, turn-taking, and edits of others. To assess the quality of the storage that the groups produced, the completeness of the notes they took were evaluated using a rubric created by the course instructor. Subsequent learning performance was assessed using the scores students received on weekly online quizzes that tested their comprehension and recall of lecture contents that they took notes on. Due to the complexity of the data, as individuals were nested within groups, the study utilized two-level correlation analysis to identify correlations among all measures.

After a thorough review of the literature on note-taking, collaborative writing, and collaborative note-taking, the results of this study were analyzed. The results were then discussed and mapped onto existing literature on the topic. To provide further context and triangulation, relevant student responses and quotes from semi-structured interviews conducted at the end of the Fall 2020 semester were provided and discussed. The present chapter concludes the dissertation with a review of the key results and a discussion of their implications, contributions, and potential applications within the field. Four major

research findings will be summarized, with each centering on one of four major research questions addressed in the study:

1. What is the relationship between collaborative behaviors and learning performance at the individual level?
2. What is the relationship between collaborative behaviors and learning performance at the group level?
3. What is the relationship between collaborative behaviors and note completeness at the group level?
4. What is the relationship between completeness and learning performance at the group level?

The chapter also provides recommendations based on the findings of this study in order to enhance the efficacy of collaborative note-taking as a learning strategy for students. The chapter closes with a discussion of the limitations of this research and possible avenues for future research on the topic.

6.1 Summary of Research Findings

The present study has addressed four research questions that relate to the effects of collaborative encoding behaviors on storage and on learning performance, as well as the effect of storage on learning performance. Overall, the results demonstrate meaningful relationships between the frequency of collaborative encoding behaviors and learning outcomes. These results suggest that collaborative encoding and storage have varying effects on learning performance and that the effectiveness of collaboration differs according to the variables investigated and the level of analysis.

6.1.1 RQ1: What is the relationship between collaborative behaviors and learning performance at the individual level?

Analysis at the level of the individual learner indicated that volume of words, edits of others, and turn-taking behaviors were all positively correlated

with learning performance. These results indicate that, for individual members of a group, the most successful encoding behaviors are *productive and interactive* rather than *sustained* in terms of their subsequent learning performance. In other words, in order to encode information into their memories, learners should contribute a large amount of notes, including writing down concepts from the lecture, responding to the notes contributed by their peers, and even engaging in editing the contributions made by their group mates. However, learners do not necessarily need to sustain these contributions across a large number of writing sessions in order to achieve these benefits to learning performance.

Therefore, with regard to Research Question 1, the present findings suggest the following: *With respect to the performance of individual learners, the intensity of collaborative encoding sessions is more important than their frequency.*

6.1.2 RQ2: What is the relationship between collaborative behaviors and learning performance at the group level?

Analysis at the level of the group indicated that turn-taking was positively correlated with learning performance, while edits of others was negatively correlated with learning performance. It is interesting to note that only the most interactive encoding variables affected learning performance at the group level. The reason these variables may be considered as the most interactive is because both edits of others and turn-taking require the contributions of multiple group members in order to occur; in other words, these two variables are inherently related to the interaction of group members. While both volume and writing sessions could occur in situations where only one member of a group contributes writing to a set of collaborative notes, edits of others would be impossible and no more than one turn could be taken in such a condition.

Although both edits of others and turn-taking produced a significant effect on learning performance at the group level, their effects contrasted, with edits of others negatively affecting and turn-taking positively affecting learning performance. The present findings suggest that interaction is a vital component

of collaborative encoding, but only to the extent that such interactions result in the addition of new information, suggestions, responses being written down (turn-taking), rather than the removal or replacement of the writing of others (edits of others). The reasons for these findings probably relate to the negative effects on group dynamics and interpersonal relationships that can occur when group members' writing is removed or altered. Such negative effects could potentially dampen the benefits that would otherwise be achieved within groups that employ a highly interactive approach to collaborative note-taking. Collaborative encoding behaviors that result in the removal of notes produced by other learners may lead to a reduction in the perceived quality of the storage among group members.

Therefore, with regard to Research Question 2, the present findings suggest the following: *With respect to the learning performance of groups, interaction is a vital component of collaborative encoding, but only when it is additive, rather than subtractive.*

6.1.3 RQ3: What is the relationship between collaborative behaviors and note completeness at the group level?

Further analysis at the group level revealed that volume of words and frequency of writing sessions were positively correlated with the completeness of group notes. These findings suggest that when creating high quality storage is the objective of collaborative note-taking, groups should be encouraged to increase the amount of encoding and to log into the document to make contributions frequently. The most highly interactive encoding behaviors of turn-taking and edits of others, which are the only measured variables that cannot occur without the contribution of multiple group members, were not shown to affect the quality of the storage groups produced, so cooperative rather than intensely collaborative approaches to collaborative note-taking may be best. An example of this would be a "divide and conquer" approach where each member is responsible for a given part of the notes and where there is minimal interaction and overlap among the written contributions to these designated sections.

Therefore, with regard to Research Question 3, the present findings suggest the following: *With respect to the quality of notes, groups should engage in a productive and sustained approach to encoding, but not a highly interactive one.*

6.1.4 RQ4: What is the relationship between completeness and learning performance at the group level?

Analysis at the group level also showed that the completeness of notes was positively correlated with learning performance. Groups that took more complete notes seem to have derived benefit from having access to this storage when studying for the weekly online courses covering the contents from the lecture videos they viewed. This result indicates that collaborative note-taking confers benefits to learning performance of groups not only through collaborative encoding, but also through the resulting storage that groups create.

Therefore, with regard to Research Question 4, the present findings suggest the following: *Collaborative note-taking groups that produce higher quality storage exhibit better learning performance than those that do not.*

6.2 Contributions

The present study represents an early attempt to examine the relationship between the quality of collaborative note-taking, in terms of both the collaborative process and resulting product, and the quality of subsequent learning performance. In this attempt, the present study has made a number of contributions to the literature as well as the practice of collaborative note-taking, and these are described in the subsections that follow.

6.2.1.1 Knowledge contribution

Recent advances in cloud computing and the development of collaborative writing tools, including the Google Docs platform that was used in this research, have enabled learners to take notes collaboratively from any

location and at any time. However, the complex interactions learners engage in while taking notes collaboratively, which are shaped by the interplay of numerous individual and social dynamics, have neither been investigated rigorously nor clearly conceptualized. As a result, the pedagogical benefits of collaborative note-taking and its effects on individual- and group-level learning performance remain unclear. The present study has helped to fill this gap through a systematic investigation of the collaborative processes students use when taking notes collaboratively and of the quality of the notes that they produce.

6.2.1.2 Theoretical contribution

In order to more clearly conceptualize the processes and product of collaborative note-taking and their relation to learning performance, the study proposed a new framework called the collaborative encoding-storage paradigm, which extends the encoding-storage paradigm (Di Vesta & Gray, 1972) to include collaborative writing behaviors and processes used when taking notes collaboratively. More specifically, the collaborative encoding-storage paradigm views collaborative note-writing behaviors as collaborative encoding and views the notes that students produce through such behaviors as collaborative storage. The findings of the present study demonstrate the utility of these concepts for conceptualizing and evaluating the effects of learners' processes when taking collaborative notes and the effects on their learning performance in a scientific writing course. The proposed framework enabled the examination of the effectiveness of various forms of collaborative encoding on learning performance from the levels of the individual and of the group. The proposed framework facilitated more detailed and nuanced explanations of the effects these collaborative encoding behaviors had on learning performance and note quality by extending an existing theoretical conception of note-taking to collaborative settings where encoding is done by individuals who are members of groups and where storage is shared by all members. The collaborative encoding-storage paradigm provides a clearer perspective on the processes

and products of collaborative note-taking than existing frameworks and that these perspectives will be useful in much needed future research on this topic.

6.2.1.3 Pedagogical contribution

The main pedagogical contribution of the present dissertation is that it provides practitioners and learners with guidance on how note-taking can be enhanced as a learning strategy. Note-taking is a nearly ubiquitous learning practice, particularly in higher education contexts, and research has repeatedly demonstrated its effectiveness in increasing learning performance. However, taking notes as a solitary task is a cognitively demanding activity, and taking notes collaboratively may help to reduce this burden by allowing students to share the labor of note-taking, thereby freeing up cognitive resources for making deeper connections with the learning material. Collaborative note-takers receive the additional benefit of exposure to varying viewpoints, perspectives, and knowledge regarding the learning material, which are shared when constructing the notes together. Lastly, the present research project has demonstrated that, when working collaboratively, students are able to produce more thorough and complete notes than when working alone, and access to this collaborative digital artifact has a positive impact on their learning performance. This dissertation provides clear recommendations for practitioners and learners about how collaborative note-taking behaviors and the completeness of notes can affect learning outcomes, and these are summarized in Section 6.3.2. Such recommendations will be of use to instructors who wish to better understand how to facilitate collaborative note-taking in their courses and can further help learners to better understand how their approaches to collaboration will affect their own learning experiences, as well as those of their group members.

6.2.1.4 Technological contribution

The present dissertation resulted in the creation of two software tools that were published in computer science conference proceedings and that are provided by my coauthor and I as freeware to instructors and researchers in

order to facilitate 1) the implementation of collaborative note-taking in the classroom and 2) the operationalization of the interaction occurring as students take notes collaboratively.

The first of these two tools is a system called Collab_Notetaking, which was created to automatically count the number of turns student groups take when constructing a collaborative document in the Google Docs platform. The system, and the paper that described it, represented the first attempt to operationally define turn-taking in the context of collaborative writing. Specifically, the system calculates turns by counting the number of instances in which co-authors interleave their text with the text contributed by other members. As extant learning analytics tools for shared online documents do not account for turn-taking, which is widely acknowledged as a crucial factor in collaboration, the Collab_Notetaking system helps to address an important blind spot with regard to collaborative processes in writing generally and note-taking specifically. This turn-taking data will be of use not only to educational researchers, but to instructors who wish to encourage high levels of interactivity among group members who are writing collaboratively.

The second tool is called Collab_doc_maker, and its purpose is to automatically create folders, subfolders, and Google Docs within the Google Drive platform. Collab_doc_maker is also used to automatically share permissions for these files and folders with pre-assigned Google accounts. The Collab_doc_maker system saved numerous hours of work in the present research project, and I believe that the system will prove invaluable to instructors who wish to implement collaborative note-taking in the courses, as it greatly reduces the burden of creating and sharing folders and files with students, in addition to providing uniformity and structure to the folders and documents. Furthermore, by freeing students from the cumbersome task of creating and sharing their own documents, the computer system can mitigate some of the extraneous cognitive costs associated with collaborative learning, enabling students to focus more of their attention on understanding course material. Lastly, by enabling instructors to automatically create all the Google Docs their students will need during the semester, the computer system

ensures that the instructor will not lose access to the Google Docs and will maintain the ability to monitor students' progress, resolve disagreements, and encourage active and balanced participation among all group members.

6.2.1.5 Methodological contribution

Research on collaboration, such as the present study, often requires multi-level analysis of collaborative behaviors because the data involves levels of nested hierarchies at the levels of the individual and the group. Therefore, the present dissertation research project introduced a novel five-step statistical model called the Courtney-Fanguy-Costley (CFC) protocol. This protocol offers a framework for statistical analysis to researchers analyzing collaborative behavior and learning performance at different levels. Such a framework will facilitate future research on collaborative note-taking as well as on other forms of collaboration.

6.3 Recommendations

Based on the results of the present study, there are two recommendations that can be made with regard to the use of collaborative note-taking as an instructional practice: the first relates to the manner in which learners encode collaborative notes and the second relates to the quality of the storage they create. The first recommendation is that, to improve students' learning performance, groups that are taking collaborative notes together should be encouraged to increase the amount of their note writing, but not the frequency of their writing sessions. The value of increased written contribution also applied to instances of interacting with and responding to the writing of group mates, as additive responses were found to be helpful to group learning performance, but subtractive changes were found to be harmful. The second recommendation is that, when creating higher-quality notes is the goal, collaborative note-taking groups should be encouraged to engage in a sustained and productive writing process, though this process does not need to be highly interactive. Instead, a cooperative writing approach will be more effective to produce highly comprehensive notes. More specifically,

practitioners should monitor collaborative note-taking environments so that they can view the progress of groups as they create notes and can encouraging regular, sustained contribution among all members.

6.4 Limitations and Suggestions for Future Research

Despite these conceptual and practical contributions, it is worth bearing in mind that learner interactions when co-creating knowledge are complex and difficult to fully observe, operationalize, and analyze. An important limitation of the present study is that, as with any correlation analysis, correlation does not indicate causality. In other words, it is not certain whether the significant correlations found in this study occurred because collaborative note-taking behaviors led to improved learning performance or whether high achieving learners engaged more actively in collaborative note-taking behaviors. However, the former seems more likely than the latter in the present study since most collaborative note-taking behaviors did not correlate with improved learning outcomes in the present study, in contrast to many of the findings and assumptions of the CSCL literature. Instead, the findings of the present study were more nuanced, with some collaborative note-taking behaviors having mildly positive correlations with learning performance, while others had no correlation, or even a mildly negative correlation in the case of edits of others at the group level of analysis. Such results suggest that the causal arrow points in the direction of collaborative note-taking behaviors having various effects on learning performance, although this cannot be proven in this study.

Another limitation of the present research is that it did not attempt to analyze embedded comments that learners added to the Google Docs when writing their collaborative notes, as there were very few such comments to analyze. Moreover, learners may have engaged in back-channel communications and processes that were integral to their collaborative note-taking; however, I was unable to examine such communications because they are inherently private.

A final caveat of the present study is that the statistical correlations were quite low at the group level, and somewhat low at the individual level. This may

be due to the lack of variation in the contribution and quality of note-taking at both the group and individual levels of analysis, as shown previously in Table 4.2.

To this end, I am currently developing more sensitive measures of collaborative writing behaviors and note-taking quality that will help to distinguish among different levels of collaboration and completeness at the group and individual levels. Specifically, I am improving the completeness rubric so that each meaningful unit represented therein directly corresponds to a quiz item. In so doing, I can better connect completeness with quiz performance for more reliable measurement. Moreover, with this improved completeness rubric, I will be able to provide an individual measurement of completeness in addition to the group measurement of this variable. These improved measures will allow me to investigate what happens in terms of learning performance when an individual writes down a meaningful unit within the collaborative notes. How is the learning performance of the individual student affected by writing down that meaningful unit in the collaborative notes? How does this writing down of a meaningful unit by an individual student affect the learning performance of the rest of the group? These are questions that I cannot currently answer with the measures I have developed for the present study, but I look forward to investigating these issues further in the coming months. In addition to this, I am also interested in extending collaborative note-taking research into other academic topics beyond scientific writing. Specifically, I would like to know how collaborative note-taking will affect learning performance in science and engineering courses, and I intend to conduct future research on this topic.

In spite of these limitations, future research may take the outcomes of the present study as a starting point and may attempt to refine the concepts of encoding and storage and to increase their explanatory power for a greater variety of collaborative note-taking activities across an array of instructional contexts and topics. As discussed in the present study, new communication platforms and software enable learners to work collaboratively at their convenience from any location, and these tools also enable instructors to observe learners' collaborative processes without being physically present.

Further research examining various communication platforms and tools and the unique instructional affordances provided by each tool can advance the research effort represented in this dissertation.

Chapter 7: Appendix One

Video list and corresponding completeness rubric codes

#	Video titles	Run times	Completeness Code
1	Overview of Scientific Writing	22:23	W2_V1
2	Parts of a Technical Paper	17:59	W2_V2
3	Introduction Section	16:50	W2_V3
4	Downloading Journal Templates	06:53	W2_V4
5	Conquering the Comma, Part 1	10:25	W2_V5
6	Conquering the Comma, Part 2	19:53	W2_V6
7	Word Choice	11:18	W2_V7
8	Verb Tense	09:11	W2_V8
9	The Introduction - Writing the Gap	07:07	W3_V1
10	Countable vs. Noncountable Nouns	09:19	W3_V2
11	Writing with Acronyms	07:55	W3_V3
12	Headings and Subheadings	11:14	W3_V4
13	Plagiarism	13:27	W3_V5
14	Quotes 1	13:54	W4_V1
15	Quotes 2	16:52	W4_V2
16	Complexity	15:09	W4_V3
17	Peer Editing	13:52	W4_V4
18	Tips for the Methodology Section	24:50	W5_V1
19	Paragraph Length	12:33	W5_V2
20	Paraphrasing	07:32	W7_V1
21	Colons and Semicolons	16:00	W7_V2
22	Hyphens	10:16	W7_V3

23	Unclear Pronoun Reference	17:16	W7_V4
24	Results Overview	09:30	W9_V1
25	Results Section - Language Conventions & Informational Elements	08:56	W9_V2
26	Illustration 1	07:28	W9_V3
27	Illustration 2	06:01	W9_V4
28	Writing with numbers	11:35	W9_V5
29	Discussion Section - Overview	06:52	W10_V1
30	Discussion Section - Researcher's Position	09:20	W10_V2
31	Discussion Section - Modal Verbs	13:00	W10_V3
32	Discussion Section - Components	07:42	W10_V4
33	Active and Passive Voice	09:19	W11_V1
34	Language 1	07:24	W11_V2
35	Language 2	09:52	W11_V3
36	Conclusion	06:39	W11_V4
37	Titles	15:42	W12_V1
38	Appendix, Key words, Glossary and Citation	10:20	W12_V2
39	Abstract	10:32	W12_V3
40	Language of the Abstract	08:48	W12_V4
41	Articles	15:21	W12_V5
42	Stacked Modifiers	08:38	W12_V6
43	Conference Posters	14:51	W12_V7
44	Corpus	08:49	W12_V8
45	How to Get Your Research Published	07:30	W14_V1
46	Choosing a journal	07:06	W14_V2
47	Open Access vs. Subscription Journals	08:22	W14_V3

48	Peer Review	11:47	W14_V4
49	Reasons for Rejection	11:14	W14_V5
50	Final thoughts	09:26	W14_V6

Chapter 8: Appendix Two

Completeness Rubric

Code	Meaningful Unit from Video
W2V1M1	How well you communicate affects your career
W2V1M2	Scientists and engineers are called upon to communicate in many different situations
W2V1M3	audiences: specific technical audiences, general technical audiences, non-technical audiences
W2V1M4	our class is general technical audiences, so many different study programmes, technical expertise but different majors
W2V1M5	Scientific writing differs from other kinds of writing
W2V1M6	writing constraints: writing constraints: audience, occasion, purpose
W2V1M7	purpose of writing: to inform, to persuade
W2V1M8	You should begin the writing process by analyzing your constraints
W2V1M9	Audience: Who they are, What they know, Why they will read, How they will read
W2V1M10	Occasion: Format, Formality, Politics and ethics, Process and deadline
W2V1M11	Three aspects of writing affect the way that readers assess your documents: Content, Style, Form
W2V1M12	Illustration --> Structure --> Style <-- Language
W2V1M13	Form embodies the format and mechanics of the writing
W2V1M14	Format: typography, layout
W2V1M15	Mechanics: grammar, usage, punctuation, spelling
W2V2M1	Beginnings prepare readers for understand the work

W2V2M2	Title - Orients the reader to the document
W2V2M3	Summary/Abstract - Tells the reader what happened in the document
W2V2M4	Introduction - Prepares the reader for the middle section
W2V2M5	Various names for summaries: summary, technical abstract, abstract, descriptive abstract, informative abstract, executive summary
W2V2M6	Although several names exist for summaries, there are essentially two approaches: Descriptive and Informative
W2V2M7	The introduction prepares the reader for the discussion
W2V2M8	Topic: Importance, background (context), arrangement (template of the journal)
W2V2M9	In the middle of a report, you present your work
W2V2M10	Choose a logical strategy
W2V2M11	Make sections and subsections (heading, subheading)
W2V2M12	Common strategies exist for the middles of scientific reports: Spatial, Chronological, Parallel parts, Flow
W2V2M13	Many journal articles follow a set organization named IMRaD: Introduction, Materials and Methods, Results, Discussion
W2V2M14	In a strong ending, you analyze results and give a future perspective
W2V2M15	Conclusions (analysis of results, future perspective)
W2V2M16	Analyze results from overall perspective
W2V2M17	Several options: Make recommendations, discuss future work, repeat limitations
W2V3M1	The introduction and conclusion should offer the reader a broad perspective on the topic
W2V3M2	The introduction should answer these questions:

W2V3M3	1. What is the problem?
W2V3M4	2. Why is it interesting and important?
W2V3M5	3. Why is it hard?
W2V3M6	4. Why hasn't it been solved before?
W2V3M7	5. What are the key components of my approach and results? Limitations?
W2V3M8	6. How is the rest of this paper organized?
W2V3M9	"Recently" is the most common word to start an introduction
W2V3M10	A strong introduction tells readers why the research is important
W2V3M11	The introduction defines the scope and limitations of the work
W2V3M12	Three classes of drinkers:
W2V3M13	1. Non-drinkers --> more likely to get social isolated
W2V3M14	2. Moderate
W2V3M15	3. Heavy drinkers
W2V3M16	20-year study, men only
W2V3M17	Drinking: release stress, socialize, communize, social aspects
W2V3M18	limitations: men only, medical history, other factors
W2V4M1	Templates are a computer document containing some basic information that you use as a model for writing other documents
W2V4M2	Why should you download journal templates?
W2V4M3	It is necessary to understand requirements for a journal
W2V4M4	Each journal is different
W2V4M5	It is better to start with what Journals require at the beginning
W2V5M1	A comma is a punctuation mark that indicates a pause is needed in a sentence
W2V5M2	Commas help to clarify meaning for the reader
W2V5M3	Separation of sentences

W2V5M4	A clause is a group of words that contains both a subject and a verb that complement each other
W2V5M5	A phrase is a group of words that does not contain a subject or a verb that complement each other
W2V5M6	A sentence that contains two independent clauses joined by a coordinating conjunction is called a compound sentence
W2V5M7	Conjunctions: for, and, nor, but, or, yet, so
W2V5M8	The comma in a compound sentence is placed before the coordinating conjunction
W2V5M9	A dependent clause contains a subject and verb, but the clause cannot stand independently
W2V5M10	Dependent clauses can often be identified by the use of dependent clause markers
W2V5M11	Dependent markers mark the beginning of a dependent clause
W2V5M12	Dependent phrases and clauses help to clarify and add detail to an independent clause
W2V5M13	Dependent clauses may appear at the beginning, middle, or end of a sentence
W2V5M14	When a dependent clause is placed at the beginning of a sentence, place a comma between the independent and dependent clauses
W2V5M15	When a dependent clause is located after an independent clause, do not place a comma between the two
W2V6M1	An essential clause or phrase is used to modify a noun
W2V6M2	It also adds information that is critical to the meaning of the sentence
W2V6M3	Essential clauses are NOT set off by commas
W2V6M4	A nonessential phrase or clause adds extra information to a sentence

W2V6M5	This information can be eliminated from the sentence without jeopardizing the meaning of the sentence
W2V6M6	Always place commas around nonessential phrases and clauses
W2V6M7	Even without the phrase, the sentence still makes sense
W2V6M8	Non-essential clauses explain or describe; essential clauses distinguish
W2V6M9	Place commas in a sentence to divide items in a list
W2V6M10	The commas will help the reader to avoid confusion
W2V6M11	Place a comma before the final item of the list, especially in technical writing-> Oxford comma
W2V6M12	Commas should be placed in series of words, phases, or clauses
W2V6M13	A comma splice is an error in which two independent clauses are joined by a comma.
W2V6M14	To Correct a Comma Splice:
W2V6M15	Insert a conjunction between the two independent clauses
W2V6M16	Start a new sentence
W2V6M17	Insert a semi-colon between the two independent clauses (only in cases where the independent clauses are closely related in topic)
W2V7M1	Frequent use of overly general or simple words prevents full expression of ideas
W2V7M2	Problem words: good, bad, big, etc.--> meaningless
W2V7M3	avoid these words (baby words) --> use more descriptive words, more meaningful words
W2V7M4	The right word can provide another layer of meaning
W2V8M1	Treat present tense as the default
W2V8M2	The first rule of thumb is to word your sentences in such a way that verb tenses are simple and consistent

W2V8M3	Use present tense when possible because it is automatically reader-friendly and readily understood
W2V8M4	Scientific truths, facts, and things happening during the reading of a paper can be treated best in present tense.
W2V8M5	Past tense is used for findings or experimental procedures and physically past events.
W2V8M6	Future tense is usually reserved for those things not yet completed. It is most useful when you want to talk about future events.
W2V8M7	Perfect tense can express when one thing happened before another, or that something began in the past and continued thereafter.
W2V8M8	Contrary to what some writers think, you may switch verb tense within a paragraph (even within a sentence)
W2V8M9	You simply must be certain that the context implied by the verb tense matches the intended meaning
W3V1M1	The introduction and conclusion should offer the reader a broad perspective on the topic
W3V1M2	The Introduction:
W3V1M3	1. Importance of your study
W3V1M4	2. Background information
W3V1M5	3. General problem
W3V1M6	4. Literature review
W3V1M7	5. Brief overview of your topic
W3V1M8	6. Gap of knowledge
W3V1M9	7. Plan of the rest of your article
W3V1M10	The Gap:
W3V1M11	1. Something at frontier/slightly improving

W3V1M12	2. What is missing? What isn't there? What hasn't been recognized
W3V1M13	3. Reason for research
W3V1M14	4. Predict future direction of research
W3V1M15	5. Clearly define the gap you are filling
W3V1M16	6. Is the gap real or an illusion?
W3V1M17	Why do we need to look for gaps?
W3V1M18	· Bringing awareness to the gap
W3V1M19	· Technological advancements
W3V1M20	· Increased knowledge by filling the gap (Einstein, Marie Curie)
W3V1M21	· Nobel prizes
W3V1M22	How to include the gap:
W3V1M23	· Clearly state what the gap is
W3V1M24	· Follows the overview of your topic
W3V1M25	· One of the most important items in the introduction
W3V1M26	· Completes the story you are telling
W3V2M1	Countable and uncountable nouns in technical papers:
W3V2M2	How do you know if a noun is uncountable?
W3V2M3	· If you don't want to or can't count it, it's probably uncountable.
W3V2M4	· Countable nouns are discrete
W3V2M5	How many informations have you gotten from this lecture so far?
W3V2M6	Information-related words tend to be uncountable
W3V3M1	Do you really need to use an acronym?
W3V3M2	Don't use an acronym...
W3V3M3	· When the term is used only once in the paper

W3V3M4	· In the title, unless the acronym is well known by anyone who would read the paper
W3V3M5	Do not define acronyms that are more well-known than the original terms
W3V3M6	Treat the abstract and the rest of the document as two separate papers
W3V3M7	· If you define an acronym in the abstract, you must define it again in the body of the paper.
W3V3M8	· Don't use an acronym in the abstract if it's used only once in the abstract.
W3V3M9	In this class, redefine acronyms in every section:
W3V3M10	· This method is new, and somewhat controversial
W3V3M11	· Keeps people from forgetting what acronyms stand for
W3V3M12	· Prevents confusion when people skip over the acronym definition
W3V4M1	The best organizational structures are those that allow the reader to anticipate what will come next.
W3V4M2	Section headings should be descriptive and parallel
W3V4M3	Non-parallel, non-descriptive:
W3V4M4	Introduction
W3V4M5	Background
W3V4M6	Results
W3V4M7	Conclusions
W3V4M8	Parallel, descriptive:
W3V4M9	Introduction
W3V4M10	Results of New Design
W3V4M11	Conclusions and Recommendations
W3V4M12	--> Predict what is coming next

W3V4M13	When you divide a section into subsections, all the pieces should be of the same pie.
W3V4M14	Organization is hidden when headings occur in a long list without secondary headings
W3V5M1	What is plagiarism?
W3V5M2	· When someone uses another person's words, ideas, or work and pretends they are his/her own
W3V5M3	· An idea, phrase, or story that has been copied from another person's work, without stating where it came from
W3V5M4	Consequences of plagiarism:
W3V5M5	1. Failure of paper
W3V5M6	2. Failure of the course
W3V5M7	3. Suspension from university
W3V5M8	4. Expulsion from university
W3V5M9	5. Lawsuit
W3V5M10	6. Destroyed reputation
W3V5M11	Types of plagiarism:
W3V5M12	Clone: Submitting another's work, word-for-word, as one's own
W3V5M13	CTRL-C: Contains significant portions of text from a single source without alterations
W3V5M14	Mashup: Mixed copied material from multiple sources
W3V5M15	Aggregator: Includes proper citation to sources but the paper contains almost no original work
W3V5M16	Re-tweet: Includes proper citation, but relies too closely on the text's original wording and/or structure
W3V5M17	Plagiarism or not?
W3V5M18	When do you need to cite?

W3V5M19	Words or ideas presented in a magazine, book, newspaper, song, etc.
W3V5M20	Information you gain through interviewing or conversing with another person, face to face, over the phone, or in writing
W3V5M21	When you copy exact words or a unique phrase
W3V5M22	When you reprint any diagrams, illustrations, charts, pictures, or other visual materials
W3V5M23	What about common knowledge?
W3V5M24	· Thing(s) that general public knows.
W3V5M25	· Regard something as common knowledge if you find the same information undocumented in at least five credible sources
W3V5M26	· When you are unsure, cite
W4V1M1	Single and double quotes are used differently in Korean and English.
W4V1M2	In Korean, double quotation marks ("...") are used to repeat, word for word, someone's exact words
W4V1M3	Single quotes ('...') are used in almost all other circumstances
W4V1M4	In English, use either double or single quotes, but not both!
W4V1M5	In American English, double quotes are almost always used.
W4V1M6	Single quotes are very rarely used in American English.
W4V1M7	A quotation within double quotes is marked with single quotes. "…..'….'…."
W4V1M8	British English prefers the exact opposite. '….."…."….'
W4V1M9	Whichever way you choose, be consistent.
W4V1M10	Capitalize the first word when quoting a complete sentence.
W4V1M11	However, do not capitalize the first word of a part of a sentence.
W4V1M12	If a quote is broken up, do not capitalize the second part of the quotation!

W4V1M13	Do not use quotation marks for indirect quotes!
W4V1M14	In a quote, use brackets to add words and ellipsis to remove them!
W4V1M15	[...] = something was added to the quote
W4V1M16	... = something was left out
W4V1M17	Use quotation marks for the titles of minor works and parts of larger works:
W4V1M18	Minor works: songs, short stories, essays, short poems, one-act plays
W4V1M19	Parts of major works: chapters in books, articles in newspapers, magazines, journals, or other publications
W4V1M20	Parts of major works (cont.): episodes of television or radio series
W4V1M21	Italicize titles of major or works that contain smaller segments:
W4V1M22	Examples: books, plays of three or more acts, and newspapers
W4V1M23	Examples (cont.): journals, periodical publications, films, and television and radio series.
W4V2M1	Use quotation marks to indicate words used ironically, sarcastically, or doubtfully.
W4V2M2	For words used as words themselves or for technical or unfamiliar terms used for the first time (and defined), use italics.
W4V2M3	Longer quotes can be introduced as a block quote followed by a colon.
W4V2M4	In American English, put commas and periods within closing quotation marks, except when a parenthetical reference follows the quotation!
W4V2M5	Put colons and semicolons outside closing quotation marks.
W4V2M6	Dashes, question marks, and exclamation points vary by case.

W4V2M7	Put a dash, question mark, or exclamation point within closing quotation marks when the punctuation applies to the quotation itself and outside when it applies to the whole sentence.
W4V3M1	Avoid making papers unnecessarily complex.
W4V3M2	Replace technical terms with simple words whenever possible.
W4V3M3	"Make everything as simple as possible, but not simpler." - Albert Einstein
W4V3M4	Decreasing complexity can increase your readership.
W4V3M5	Replace jargon with simple words to reduce complexity.
W4V3M6	In the Gunning Fog Index, the complexity of writing depends on two factors.
W4V3M7	1) the lengths of sentences
W4V3M8	1) the lengths of words
W4V3M9	Desired index values for scientific writing are 10-12.
W4V3M10	Fi = 0.4 ((Nw/Ns)+Plw)
W4V3M11	Nw = # of words, Ns = # of sentences, Plw = % of long words
W4V3M12	Gunning Fog Index calculator: http://gunning-fog-index.com/
W4V3M13	Try to keep your score below 30.
W4V4M1	Conduct a study --> Write a paper --> Submit to a journal --> Peer review --> Accept/revise/reject
W4V4M2	Peer editing is an extension of this experience. It consists of the following.
W4V4M3	· Peer response
W4V4M4	· Peer review
W4V4M5	· Peer feedback
W4V4M6	· Peer evaluation
W4V4M7	Why is peer editing necessary?
W4V4M8	· Clarification of ideas

W4V4M9	· Significance of details
W4V4M10	· Logical flow of ideas
W4V4M11	· Grammar
W4V4M12	· Mechanics
W4V4M13	What are the benefits of peer editing?
W4V4M14	1. Experience giving/receiving constructive feedback on writing.
W4V4M15	2. Develop critical thinking and editorial skills.
W4V4M16	3. Can significantly improve the revised draft in peer editing (compared to self-editing).
W4V4M17	
W4V4M18	1. Be a reader/editor.
W4V4M19	2. Take time to understand and give quality feedback.
W4V4M20	3. Be reflective.
W5V1M1	Summary of scientific paper:
W5V1M2	1) Title
W5V1M3	2) Authors and addresses
W5V1M4	3) Abstract
W5V1M5	IMRAD:
W5V1M6	1) Introduction
W5V1M7	2) Methods and materials
W5V1M8	3) Results
W5V1M9	4) Discussion
W5V1M10	5) Conclusion
W5V1M11	Reproducibility is the cornerstone of science and scientific investigations, in general.
W5V1M12	Review writing tips for methods:

W5V1M13	In general, the Methods and Materials should include the following:
W5V1M14	Any investigation:
W5V1M15	1) Overview of the experiment or study
W5V1M16	2) Procedures
W5V1M17	3) Materials
W5V1M18	4) Variables
W5V1M19	Might it be limited to experimental investigations?
W5V1M20	1) Population/Sample/Location
W5V1M21	2) Restricting/Limiting Conditions
W5V1M22	3) Sampling techniques
W5V1M23	Some investigations:
W5V1M24	1) statistical treatments
W5V1M25	Of course, not all scientific investigations are experimental in nature.
W5V1M26	Parts of the methodology:
W5V1M27	1) Provide a general introduction and overview of the materials/methods.
W5V1M28	2) Restate the purpose of the work
W5V1M29	3) Give the source of the materials and/or equipment used.
W5V1M30	4) Supply essential background information
W5V1M31	5) Provide specific and precise details about materials and methods i.e. quantities, temperatures, duration, sequence, conditions, locations, sizes
W5V1M32	6) Justify that choices made indicate that appropriate care was taken.
W5V1M33	7) Relate materials/methods to other studies.
W5V1M34	8) Indicate where problems occurred.

W5V1M35	Writing tips for methods:
W5V1M36	Most of this section will be written in the past tense.
W5V1M37	1) If you are describing something that you did, use the past tense.
W5V1M38	2) If you need to describe currently accepted practices, use the present tense.
W5V1M39	Write any procedure in chronological order.
W5V1M40	Try to give the old information first and the new information second.
W5V1M41	The passive voice is usually used to avoid I/We;
W5V1M42	However, active voice is not forbidden. Try to make passive structures using short passive forms.
W5V1M43	Good writing practice: because/since/as:
W5V1M44	Look at these sentences...anything odd?
W5V1M45	1) Because electrons are charged, they respond to magnetic fields.
W5V1M46	2) Since energy is neither created nor destroyed, it is a conserved quantity.
W5V1M47	3) As earth rotates, we experience night and day.
W5V1M48	Sentence (1) is not so bad; some claim that starting a sentence with "because" is inelegant
W5V1M49	CAVEAT: "since" and "as" can have multiple meanings!
W5V1M50	"SINCE"
W5V1M51	1) Equivalent to "because"
W5V1M52	2) From past time to the present
W5V1M53	"AS"
W5V1M54	1) because
W5V1M55	2) to the same degree, amount, or extent; similarly, equally

W5V1M56	3) for example, for instance
W5V1M57	4) thought to be or considered to be
W5V1M58	5) in the manner of
W5V1M59	6) at the same time that
W5V1M60	7) … 27 more!
W5V1M61	Example: I didn't hear her enter as I was concentrating.
W5V1M62	Decipher: Copper ions are generated and extracted from a Bernas ion source with a heating crucible that provides feed gasses to sustain the plasma.
W5V1M63	Problem: “the ions are extracted with a heating crucible"?
W5V1M64	Revised: Copper ions were generated and extracted from a Bernas ion source. For the latter, a heating crucible provided the feed gasses necessary to sustain the plasma.
W5V2M1	Keep paragraphs short and unified!
W5V2M2	1) Usually range from three to five sentences long
W5V2M3	2)One sentence standing alone does not qualify as a paragraph
W5V2M4	Must be unified under one main idea or theme
W5V2M5	Shorter paragraphs = Happier readers
W5V2M6	Research shows that people generally have a more positive attitude towards technical writing with paragraphs of 100 or less words.
W5V2M7	Summary for paragraph length:
W5V2M8	1) Paragraphs should have one major idea/theme.
W5V2M9	2) Keep paragraphs short (3-5 sentences).
W5V2M10	3) Shorter paragraphs are preferable and leave a better impression with readers.
W5V2M11	4) Shorter paragraphs increase white space!
W5V2M12	5) Longer paragraphs may intimidate readers!

W5V2M13	6) Readers prefer shorter paragraphs because they look and are more organized.
W7V1M1	Paraphrasing means to put information from a source into your own words
W7V1M2	Generally the same length or slightly shorter than the original source
W7V1M3	More than just using the same words and phrases
W7V1M4	Replace some of the words with synonyms
W7V1M5	Change active constructions to passive, and vice versa
W7V1M6	Change words into other parts of speech: adjectives into verbs, verbs into nouns, etc.
W7V1M7	Move parts of sentences around.
W7V2M1	Colon: a colon introduces a formal list, long quotation, equation, or definition.
W7V2M2	Colon: We studied five types of marsupials: opossums, bandicoots, koalas, wombats, and kangaroos
W7V2M3	Typical structure: Independent clause (general info): specific info
W7V2M4	Semicolons can join two independent clauses.
W7V2M5	Semicolons separate items in a complex list
W7V3M1	Compound nouns 1: Made up of two or more words
W7V3M2	Compound nouns 2: Most compound nouns are made with nouns that have been modified by adjectives or other nouns
W7V3M3	Compound nouns 3: The first words usually describes the second
W7V3M4	Compound nouns 4: either: Open compound nouns, Closed compound nouns, Hyphenated compound nouns
W7V3M5	When to use hyphens:• To indicate that two or more words are acting as a single concept to describe the following noun

W7V3M6	When to use hyphens:• If the adjectives come after the noun, then they don't need a hyphen
W7V3M7	When to use hyphens:• When writing numbers: twenty-one through ninety-nine
W7V3M8	When to use hyphens:• Eliminate ambiguity
W7V3M9	When to use hyphens:• Create compound nouns
W7V3M10	When to use hyphens:• Two+ words acting as a single concept describing the noun
W7V3M11	In general, do not use a hyphen with a prefix
W7V3M12	However, some prefixes need hyphens, such as re-, mid-, and ex-:
W7V3M13	And to connect numbers and/or letters used as prefixes to a noun:
W7V3M14	As well as to separate vowels or consonants that would otherwise merge together:
W7V3M15	A series end with the same term doesn't have to be repeated:
W7V3M16	With prefixes that come before a word that needs a capital letter:
W7V3M17	Don't use a hyphen when you have a compound modifier that consists of an adverb ending in -ly:
W7V3M18	Don't stack modifiers:
W7V4M1	A pronoun takes the place of a specific noun that has already been mentioned.
W7V4M2	The noun that a pronoun refers to is its antecedent
W7V4M3	Three common pronoun-antecedent problems: Missing or Faraway Antecedents
W7V4M4	Three common pronoun-antecedent problems: Anticipatory Reference: Problem of putting pronouns before the antecedent.
W7V4M5	Three common pronoun-antecedent problems: Ambiguous Antecedents: Confusion from having several antecedents for the pronoun

W9V1M1	To show the significance of your results
W9V1M2	To relate your results to the research goals
W9V1M3	To offer some more background information
W9V1M4	To suggest reasons why your results were not as successful you had hoped
W9V1M5	To communicate your own understanding and interpretation of your results
W9V1M6	Useful resource: Science Research Writing, pp. 94-110: Language areas important in the results section
W9V1M7	Components: 1. Revisiting the research aim/existing research, Revisiting/Expanding methodology, General overview of results
W9V1M8	Components: 2. Invitation to view results, Specific/Key results in detail, with or without explanations, Comparisons with results in other research, Comparison/s with model predictions
W9V1M9	Components: 3. Problems with results
W9V1M10	Components: 4. Possible implications of results
W9V2M1	Invitation to view results
W9V2M2	Specific/Key results in detail, with explanations
W9V2M3	Language conventions
W9V2M4	Statements that: • locate the figures • present the most important findings • comment on results
W9V2M5	Conventional form:
W9V2M6	Short form (findings + locator):
W9V2M7	Locator statements: active or passive
W9V2M8	Present different types of findings: • Comparison among groups
W9V2M9	Present different types of findings: • Fluctuation of a variable over time

W9V2M10	Present different types of findings: • Relationship between two or more variables
W9V2M11	Statements commenting on your findings: 1. Explanation of the findings: Present tense, modal verbs
W9V2M12	Statements commenting on your findings: 2. Comparison of other studies: Present tense
W9V2M13	Statements commenting on your findings: 3. Generalization of the results: Modal verbs, tentative verbs
W9V3M1	The meshing of words with images (part one).
W9V3M2	Two types of illustrations exist: tables and figures.
W9V3M3	Tables can present words as well as numbers.
W9V3M4	When presenting numerical data, you choose between tables and graphs.
W9V3M5	Line graphs are common in engineering and science.
W9V3M6	Bar graphs compare wholes.
W9V3M7	Gantt charts are a type of bar chart.
W9V3M8	Pie charts compare parts of a whole.
W9V3M9	Graphs come in many forms.
W9V4M1	When presenting images, you choose between photographs, drawings, and diagrams.
W9V4M2	The main advantage of photographs is realism.
W9V4M3	One advantage of drawings is control of detail.
W9V4M4	The main advantage of a diagram is the ability to show flow of a variable through a system.
W9V4M5	The precision of the illustrations should reflect the precision of the text.
W9V4M6	For clarity, you should introduce and explain illustrations in the text.

W9V4M7	Inconsistencies between text and images disrupt fluidity.
W9V4M8	Illustration is the meshing of words with images.
W9V5M1	There are no standard rules: Rules for writing numbers vary greatly
W9V5M2	Use words for numbers between one and nine: · Check a template or style guide for clarity
W9V5M3	Numerous exceptions to these rules exist: • Page numbers
W9V5M4	Numerous exceptions to these rules exist: • Figure numbers
W9V5M5	Numerous exceptions to these rules exist: • Negative numbers
W9V5M6	Numerous exceptions to these rules exist: • Decimals
W9V5M7	Numerous exceptions to these rules exist: • Specific measurements
W9V5M8	Numerous exceptions to these rules exist: • Percentages
W9V5M9	Numerous exceptions to these rules exist: • Monetary figures
W9V5M10	Numerous exceptions to these rules exist: • Large numbers
W9V5M11	Try to avoid starting sentences with numerals
W9V5M12	If you write one number as a numeral, do it for all numbers of the same type:
W9V5M13	With two numbers next to each other, write one out and use numerals for the other
W10V1M1	Four options: table
W10V1M2	Introduction section: table
W10V1M3	Shape of a research article: introduction, central report section (methodology, results), discussion/conclusion
W10V1M4	Comparison of Introduction and Discussion: table
W10V1M5	Main components of the discussion section: 1. Revisiting previous sections Summarizing/Revisiting general or key results

W10V1M6	Main components of the discussion section: 2. Mapping
W10V1M7	Main components of the discussion section: 3. Achievement/contribution, Refining the implications
W10V1M8	Main components of the discussion section: 4. Limitations, Current and future work, Applications
W10V2M1	Explanation: One possible explanation is that speed jobs do not tax older workers to their limits
W10V2M2	Implication: We can no longer assume that it is satisfactory to seek explanations only in economic factors
W10V2M3	Limitation: We acknowledge that other industries may produce different results
W10V2M4	Application: Clearly, this technique has promise as a tool in the evaluation of forages
W10V2M5	Complex grammatical structure:
W10V2M6	Complex sentence structure in discussion statements: Main clause+that+ noun clause
W10V2M7	Noun clauses: • that-clause • -if/whether-clause • Question clause
W10V2M8	Expressions for restating the hypothesis:
W10V2M9	Simple past: Referring to the purpose
W10V2M10	Simple past: Referring to the hypothesis
W10V2M11	Simple past: Restating the findings
W10V2M12	Past, present and modal verbs: Explaining the findings
W10V2M13	Past, present and modal verbs: Limiting the findings
W10V2M14	Past, present and modal verbs: Implications
W10V2M15	Past, present and modal verbs: Recommendations and applications

W10V3M1	Modal verb usage:• Ability/Capability• Possibility/Options• Probability/Belief/Expectation• Virtual certainty• Advice/Opinion• Necessity/Obligation
W10V3M2	Modals are different from regular verbs:• Do not have subject-verb agreement
W10V3M3	Modals are different from regular verbs:• Do not take the infinitive "to" before the next verb
W10V3M4	Modals are different from regular verbs: Some change their meaning in the negative form
W10V3M5	What is the difference?
W10V3M6	Modal verbs: Do not follow standard grammar rules
W10V3M7	Modal verbs: Convey nuances of meaning
W10V3M8	Modal verbs: Have more than one meaning
W10V3M9	1. Ability/Capability: table (can)
W10V3M10	2. Possibility/Options: table (may, might, could, can)
W10V3M11	3. Probability/Belief/Expectation: table (should, ought to)
W10V3M12	4. Virtual certainty: table (must, have to)
W10V3M13	5. Advice/Opinion: table (should, ought to)
W10V3M14	6. Necessity/Obligation: table (must, need to, have to)
W10V4M1	Main components of the discussion section: Revisiting previous sections, Summarizing/Revisiting general or key results
W10V4M2	Main components of the discussion section: Mapping
W10V4M3	Main components of the discussion section: Achievement/contribution, Refining the implications
W10V4M4	Main components of the discussion section: Limitations, Current and future work, Applications
W11V1M1	In active voice, the subject in a sentence performs the action.
W11V1M2	In passive voice, the subject is being acted upon by the verb.

W11V1M3	Passive voice with the word "by" tells who does the action.
W11V1M4	Argument for active voice -> Active voice is usually shorter than passive voice.
W11V1M5	Passive is prone to abusive nominalization.
W11V1M6	Journals usually prefer active voice because it is likely less ambiguous.
W11V1M7	Nature journals like authors to write in active voice.
W11V1M8	Active voice appropriately expresses science.
W11V1M9	Argument for passive voice -> The performer is unknown, irrelevant, or obvious.
W11V1M10	Emphasis on what was done.
W11V1M11	Less use of personal pronouns:
W11V1M12	Control of sentence structure.
W11V1M13	Make sure your passive sentences are intentional and not habitual.
W11V1M14	Use the passive voice when necessary to maintain cohesion.
W11V1M15	When you use the passive voice, make sure the actor is not ambiguous and avoid abusive nominalizations.
W11V2M1	For precise language, you should avoid over-specifying details.
W11V2M2	For precision, you must choose the appropriate level of detail.
W11V2M3	Complex wording buries ideas.
W11V2M4	Stacking adjectives before nouns swallows the ideas.
W11V2M5	One measure for the complexity of the writing is the Gunning Fog Index:
W11V2M6	In the index, the complexity of the writing depends on the length of sentences and the length of words.
W11V2M7	Desired index values for scientific writing are 10-12:
W11V2M8	Fi = 0.4 ((Nw/Ns)+Plw)

W11V2M9	Nw = number of words in a typical paragraph
W11V2M10	Ns = number of sentences in the paragraph
W11V2M11	Plw = percentage of long words in the paragraph
W11V3M1	An ambiguity is a group of words that can have more than one meaning.
W11V3M2	Ambiguities occur for many reasons.
W11V3M3	Pretentious diction often causes problems with tone.
W11V3M4	A formal definition has a specific form: noun term --> noun naming class to which noun term belongs --> information to separate noun term from other terms in class
W11V3M5	Weak verbs hide the energy of your work.
W11V3M6	To tighten your writing, eliminate redundancies and writing zeroes. Examples include the following.
W11V3M7	1) as a matter of fact
W11V3M8	2) I might add that
W11V3M9	3) it is noteworthy that
W11V3M10	4) It is significant that
W11V3M11	5) It should be pointed out that
W11V3M12	6) the course of
W11V3M13	7) the fact that the presence of
W11V3M14	Examples anchor abstract generalities.
W11V3M15	When sentence openers do not vary, the sentences do not seem to connect:
W11V3M16	Vary sentence openers to vary rhythm:
W11V3M17	Varying sentence openers enlivens the writing and allows connections.
W11V4M1	There are four options to write the conclusion section.
W11V4M2	Results or Data Analysis + Discussion + Conclusion(s)

W11V4M3	Results or Data Analysis + Discussion
W11V4M4	Results and Discussion + Conclusion(s)
W11V4M5	Results or Data Analysis + Discussion and Conclusion(s)
W11V4M6	The Conclusion analyzes the most important results and discusses the significance of the work.
W11V4M7	The significance of the work adds practical application(s), gives advice, implies an action, and provides a proposition.
W11V4M8	The level of certainty is the highest for the practical applications and the lowest for the proposition.
W12V1M1	Why should you care about titles?
W12V1M2	1. Many people read them
W12V1M3	2. They act as "matchmakers" between your paper and the right readers, who need and want the information in your paper.
W12V1M4	3. Editors and reviewers read and can leave editors and reviewers with a strong first impression.
W12V1M5	A strong title orients readers to your area of work.
W12V1M6	A strong title also separates your work from everyone else's work.
W12V1M7	Don't trick people with titles.
W12V1M8	· Writing a misleading title can hurt you by:
W12V1M9	- wasting the reader's time
W12V1M10	- ruining your reputation
W12V1M11	What is the function of titles?
W12V1M12	· to catch the reader's interest
W12V1M13	· to predict content/tell aim of the paper
W12V1M14	· to differentiate your paper from other papers in the same subject area
W12V1M15	· When you read the title by itself, does it give a brief and accurate description of the content of the paper?

W12V1M16	Titles should be simple, brief and attractive.
W12V1M17	· usually 10-12 words
W12V1M18	· accurately reflect the content of the paper
W12V1M19	· contain active verbs instead of noun-based phrases
W12V1M20	Titles should use appropriate descriptive words.
W12V1M21	· should contain key words used in your article
W12V1M22	· think about terms people would use to search your study
W12V1M23	To capture the reader's attention, put keywords first in titles.
W12V1M24	Titles should not contain waste words.
W12V1M25	· Take out words that do not carry information:
W12V1M26	- articles (a, an, the)
W12V1M27	- phrases (investigation of, study on/of)
W12V1M28	Is the title concise and accurate in giving the reader an idea of content in the paper?
W12V1M29	Titles should avoid abbreviations and jargon.
W12V1M30	· Acronyms, specific abbreviations, formulas, and jargon that may not be familiar to readers should be left out.
W12V1M31	Titles can use colons for clarity.
W12V1M32	Don'ts:
W12V1M33	· Do not capitalize:
W12V1M34	- articles (a, an, the)
W12V1M35	- coordinating conjunctions (and, but, or, nor, so)
W12V1M36	- to when it precedes a verb
W12V1M37	- prepositions with fewer than 5 letters
W12V1M38	· Do not use roman numerals (V, X) since they can be understood differently
W12V1M39	Titles should follow the style of the journal.

W12V2M1	The Index:
W12V2M2	1. Long documents require an index.
W12V2M3	2. Include every important topic and subject of paper here. If in doubt, include it.
W12V2M4	3. Most indexes consist of two levels.
W12V2M5	4. Use cross references to guide reader.
W12V2M6	Appendix: Include nonessential material here:
W12V2M7	1. Detailed explanations.
W12V2M8	2. Additional diagrams.
W12V2M9	3. Tables summarizing data.
W12V2M10	4. Experimental protocols or survey questions you used.
W12V2M11	5. Selected computer code relevant to paper.
W12V2M12	How to format the Appendix:
W12V2M13	1. If there is more than one appendix, use letters (Appendix A, Appendix B).
W12V2M14	2. Give each appendix an appropriate title.
W12V2M15	3. Limit each appendix to one topic.
W12V2M16	4. Begin each appendix on a new page.
W12V2M17	5. Start each appendix with summary paragraph.
W12V2M18	6. Refer to each appendix in main paper.
W12V2M19	**7. Do not use as a dumping ground!**
W12V2M20	Use appendices to supply background for secondary audiences:
W12V2M21	Appendix A
W12V2M22	Use appendices to supply secondary or tangential information to primary readers:
W12V2M23	Appendix B
W12V2M24	For secondary readers, use a glossary to define unfamiliar terms:

W12V2M25	Glossary
W12V2M26	Regarding Key Words...
W12V2M27	· Key words are words that others will use to find your paper.
W12V2M28	· Use words that are clear in meaning.
W12V2M29	· Usually one word. - Example: 3D, Heart, etc.
W12V2M30	· Usually no longer than three words long
W12V2M31	· Better to have too many KWs than too few
W12V2M32	· Leads to the citation of your publication by others
W12V2M33	Failing to cite the contribution of others can be a fatal flaw in your career. - Always cite others.
W12V3M1	Abstracts are the shortest but most important section of a technical article:
W12V3M2	· A single paragraph of less than 200 words.
W12V3M3	· Written for the same audience as the article.
W12V3M4	· The most commonly read part of your paper.
W12V3M5	The abstract should clearly and concisely answer the following three questions:
W12V3M6	· What did you do?
W12V3M7	· What did you find?
W12V3M8	· Why is it important?
W12V3M9	Abstracts are used in a variety of writing situations:
W12V3M10	· In research articles in journals.
W12V3M11	· In review articles.
W12V3M12	· In chapters in a book, if each chapter has a different author.
W12V3M13	· In library reference tools, such as Biological Abstracts.
W12V3M14	· For presentations at scientific meetings.
W12V3M15	Examine outstanding abstracts on your own:

W12V3M16	· The best source of example abstracts is journal articles.
W12V3M17	· Look for examples where the abstract makes the article easier to read. How did they do it?
W12V3M18	· Not everyone writes good abstracts, even in refereed journals.
W12V4M1	Sentences in an abstract should be short and simple:
W12V4M2	· Avoid long, complicated sentences.
W12V4M3	· Break separate thoughts into separate sentences.
W12V4M4	· Limit use of commas, colons, and semicolons.
W12V4M5	· Limit use of conjunctions (and, but, or).
W12V4M6	Every word in an abstract must have purpose:
W12V4M7	· Avoid noninformative phrases and abbreviations
W12V4M8	· Do not use "etc." or "and similar observations"
W12V4M9	· Do not include bibliographic citations
W12V4M10	· Avoid repetition
W12V4M11	If you have results, state them.
W12V4M12	You must also state nonsignificant results.
W12V4M13	Do not speculate on future experiments in the abstract.
W12V5M1	What are determiners?
W12V5M2	· a word that is used before a noun in order to show which thing you mean
W12V5M3	· My, this, one, a, some, the
W12V5M4	**Types of articles**
W12V5M5	Indefinite → a/an
W12V5M6	a→ consonant sounds
W12V5M7	An→ vocal sounds, vowel sounds
W12V5M8	Definite → the
W12V5M9	No article

W12V5M10	When do you use a/an
W12V5M11	one/singular → what words they go with (countable/non-countable noun)
W12V5M12	Use a if it doesn't matter or you don't know or your reader doesn't know which thing/person you are referring to.
W12V5M13	2nd mention
W12V5M14	Specific/known
W12V5M15	*Use the if or when you and your reader both know which thing/person you mean.*
W12V5M16	*Use the if there is only one possible referent*
W12V5M17	This effect may hide a connection between the two
W12V5M18	This effect may hide the connection between the two
W12V5M19	When do you use no articles → Use no articles when generalizing about uncountable nouns and plural countable nouns
W12V5M20	Water is an important resource → uncountable and general things
W12V5M21	Vegetables are good for you → Plural form of countable noun
W12V5M22	All articles can be used to express general truths
W12V6M1	Modifiers and modifier stacking:
W12V6M2	· Modifiers describe, or modify, other words.
W12V6M3	· Adjectives modify nouns or pronouns, for example, and adverbs modify verbs, adjectives, or other adverbs.
W12V6M4	· Modifier Stacking refers to long strings of modifiers in front of nouns.
W12V6M5	Single-word modifiers:
W12V6M6	· Describe other words.
W12V6M7	· Adjectives --> nouns, pronouns.
W12V6M8	· Adverbs --> verbs, adjectives, adverbs.
W12V6M9	· Easy to handle.

W12V6M10	Multiple-word modifiers:
W12V6M11	· Same function as single-word modifiers.
W12V6M12	Be careful with modifiers:
W12V6M13	· Science and technical prose depends heavily on modification.
W12V6M14	· Writers often stack modifiers.
W12V6M15	Modifier stacking.
W12V6M16	Modify in moderation:
W12V6M17	· Take three modifiers as the maximum limit when describing a noun.
W12V6M18	· Use hyphens.
W12V6M19	· Break sentences into two.
W12V6M20	· Get rid of some modifiers.
W12V6M21	· Add words (conjunctions and prepositions).
W12V7M1	Conference posters are different from journal articles:
W12V7M2	· Read in crowded, hectic environments.
W12V7M3	· Must appeal to the reader visually.
W12V7M4	· Must be designed for quick & easy reading.
W12V7M5	The title of an effective poster should quickly orient the audience:
W12V7M6	· Suggestions:
W12V7M7	1. Make the title the most prominent text.
W12V7M8	2. Do not use all caps.
W12V7M9	3. Sentence titles are more effective than phrases
W12V7M10	Give your poster the 20-second test:
W12V7M11	· Can the reader recognize the subject and purpose within 20 seconds of seeing the poster?
W12V7M12	The specific sections should be easy to locate on the poster.
W12V8M1	What is a corpus?

W12V8M2	· A large collection of written or spoken language that is used for studying the language.
W12V8M3	Common mistakes:
W12V8M4	· Especially, it was found that information representation, divided into text and graphic formats, strongly connected to user characteristics in decision making (Benbasat & Dexter, 1985).
W12V8M5	· 특히
W12V8M6	· Many researchers have been investigated in various fields.
W12V8M7	· Researches.
W12V8M8	Collocations:
W12V8M9	· The combination of words formed when two or more words are often used together in a way that sounds correct (to native speakers of a language)
W12V8M10	· What are the top two prepositions that appear with the noun "research"?
W14V1M1	The peer review process
W14V1M2	Two basic editorial structures
W14V1M3	Professional in-house editors: • Scientifically trained (usually to PhD/MD level). • Now full-time work on journals
W14V1M4	Supported by ed boards and other experts
W14V1M5	External academic editors: • Practicing scientists and clinicians • Established experts in their field • Working closely with associate editors, delegating to editorial boards
W14V1M6	Check the editorial model from the journal's information pages.
W14V1M7	Key steps in the peer-review process:
W14V1M8	Step 1: Manuscript submission:
W14V1M9	· Usually online.

W14V1M10	· Read instructions for authors and journal policies before submission.
W14V1M11	· Submitting author takes responsibility for "agreeing" to terms and conditions.
W14V1M12	: Manuscript submission: Presubmission enquiries (some journals):
W14V1M13	· Usually quick response.
W14V1M14	· Important for journals with large submission numbers.
W14V1M15	· Initial agreement of the editors to consider the manuscript for peer review - first hurdle taken.
W14V1M16	· Usually required: Well-written abstract outlining key questions, results, and novel insights.
W14V1M17	· Usually required: Detailed cover letter, explaining significance of new insights, methods used and date represented.
W14V1M18	: Manuscript submission: Cover letter:
W14V1M19	· Important first impression.
W14V1M20	· Address to the editor personally.
W14V1M21	· Provide manuscript title and publication type (research, review, etc.).
W14V1M22	· Background, rationale, description of results.
W14V1M23	· Explain importance of your findings:
W14V1M24	· Provide corresponding author details.
W14V1M25	Step 1: Manuscript submission: Recommending reviewers:
W14V1M26	· Experts with good publication records - in areas covered in the manuscript.
W14V1M27	· Do not recommend your collaborators to close colleagues.
W14V1M28	Excluding reviewers:
W14V1M29	· Provide good reasons for excluding: e.g. Close competition.

W14V1M30	· Do not exclude more than 2-3 people.
W14V1M31	Step 2: Initial manuscript assessment:
W14V1M32	· Journal scope.
W14V1M33	· Potential interest level.
W14V1M34	· Policies (ethics, data availability, etc.).
W14V1M35	· Novelty, including plagiarism/duplication.
W14V1M36	· Basic quality of language and presentation (mostly abstract, figures, etc.).
W14V1M37	Step 3: Peer review stage:
W14V1M38	· Usually 2-4 experts, depending on expertise required.
W14V1M39	· Often many experts need to be invited; good experts are busy.
W14V1M40	· Peer reviewers provide recommendations and advice on:
W14V1M41	Step 4: Editorial decision:
W14V1M42	· The editor integrates the information received from different experts.
W14V1M43	· Not democratic process. ALL important issues must be resolved.
W14V1M44	--> First decision:
W14V1M45	- Accept manuscript.
W14V1M46	- Invite revisions (major/minor) - revised manuscript may need to repeat steps
W14V1M47	- Reject.
W14V2M1	Publishing your research.
W14V2M2	Open Access publishing vs. subscription journal publishing.
W14V2M3	The old world of access to knowledge: Library.
W14V2M4	The new world of access to knowledge: Internet.
W14V2M5	The changing landscape of open access.
W14V2M6	Know your options:

W14V2M7	· Traditional/closed access journal.
W14V2M8	· Open Access (OA) journal.
W14V2M9	Gold OA
W14V2M10	Article is published in an Open Access journal
W14V2M11	Final published version of work free for anyone to read online immediately after publication
W14V2M12	May include article publishing charges (APCs) paid by the author, or on his/her behalf by institutions or funders (one-time free)
W14V2M13	Less stringent licensing restrictions to maximize access, re-use and dissemination
W14V2M14	Green OA
W14V2M15	Articles is self-archived in an online repository (subject or institutional), archive or website after publication
W14V2M16	Pre-print, post-print or final published version of work free anyone to read online; sometimes an embargo period (usually 6-24 months) applies
W14V2M17	Publishing expenses paid by subscribers, no additional charges for authors
W14V2M18	Flexible licensing options that allow for more author control over his/her work
W14V2M19	Open Access vs. traditional journals:
W14V2M20	1. Visibility - Greater audience.
W14V2M21	2. Cost - Set free (APC) vs. per page.
W14V2M22	3. Prestige - PLOS ONE ranked 1st by IF.
W14V2M23	4. Speed - "accelerating the publication of peer-reviewed science".
W14V2M24	Every journal has high standard review processes:
W14V2M25	· 2-3 or more independent expert reviewers.

W14V2M26	· Statistical referees where needed.
W14V2M27	· Editors-in-Chief, editorial board members and referees are prestigious academics and clinicians.
W14V2M28	· Acceptance rates are on average 45-55%.
W14V2M29	· Some highly selective journals with acceptance rates <10%.
W14V3M1	What do editors and reviewers look for?
W14V3M2	Get your research published: Choosing a journal:
W14V3M3	What are the most important factors for authors?
W14V3M4	· Prestige of the journal.
W14V3M5	· Target readership.
W14V3M6	· Visibility.
W14V3M7	· Open Access.
W14V3M8	· Speed of peer-review process.
W14V3M9	Finding the major journals that publish studies in your area of research:
W14V3M10	Journal prestige:
W14V3M11	· Impact factor.
W14V3M12	· SciMago rankings.
W14V3M13	· Editorial board.
W14V3M14	Journal information pages: aims and scope.
W14V3M15	How to judge a journal's visibility: Article accesses/alternative metrics.
W14V3M16	Editors and reviewers look for:
W14V3M17	· Does the work fit within the journal's scope?
W14V3M18	· Is the article sound science?
W14V3M19	· What is new and useful/interesting?

W14V3M20	· Is it a big enough step forward for this journal's readership? Note:
W14V3M21	Novelty
W14V3M22	Significance
W14V3M23	Interest levels vary between journals:
W14V3M24	High threshold --> Low threshold
W14V3M25	· High threshold:
W14V3M26	- Significant advance.
W14V3M27	- Results and insights of wider interest/can be generalized.
W14V3M28	- Resources, methods need to be widely usable.
W14V3M29	- Conclusions must be strong.
W14V3M30	· Low threshold:
W14V3M31	- Advance can be small.
W14V3M32	- Results and insights of interest to a specialized group.
W14V3M33	- Conclusions can be "weaker" - e.g. statistically less strong.
W14V3M34	- Caveats about limitations of a study, missing controls, etc.
W14V3M35	How to choose your target journal:
W14V3M36	· Honestly evaluate your findings:
W14V3M37	How big of an advance are your findings?
W14V3M38	How high can you realistically aim?
W14V3M39	· Check aims and scope of several journals:
W14V3M40	Who reads them?
W14V3M41	Who published in them?
W14V3M42	How much do they charge?
W14V3M43	What type of studies have they published recently?
W14V3M44	Novelty: Aims and Scope
W14V3M45	Significance: Impact Factor

W14V4M1	Reason 1: Results are not sound:
W14V4M2	· Further controls needed:
W14V4M3	· Sample size is too small.
W14V4M4	· Control samples are inappropriate.
W14V4M5	· Further statistical analysis needed:
W14V4M6	· Statisticians advice on the appropriate tests.
W14V4M7	· Sample sizes too small to give meaningful results.
W14V4M8	· Methods used are inappropriate:
W14V4M9	· More sensitive/accurate methods are available.
W14V4M10	· Methods have limitations under these conditions.
W14V4M11	Reason 2: Interpretations are wrong and overstated:
W14V4M12	· Key references/relevant previous studies ignored:
W14V4M13	· The submitted work is not novel
W14V4M14	· References are mostly old
W14V4M15	· Arguments/models not supported by data:
W14V4M16	· The new findings don't fit with existing knowledge/accepted models in the field. Is there an explanation?
W14V4M17	· The new findings contradict previous publications. There must be very strong evidence (good controls, etc.) that the new findings are the correct ones.
W14V4M18	Reason 3: Findings are not big or interesting enough:
W14V4M19	· Conclusions are not strong:
W14V4M20	· Sample sizes are small, controls are not comprehensive and results are overstated.
W14V4M21	· Toning down the conclusions makes it too weak for a high-profile journal.
W14V4M22	· "Not interesting" enough:

W14V4M23	· Not of broad enough appeal.
W14V4M24	· Doesn't meet journal's threshold.
W14V4M25	Reason 4: Ethical concerns:
W14V4M26	· Plagiarism: Copying and pasting is unacceptable.
W14V4M27	· Duplication: Present new findings not published elsewhere.
W14V4M28	· Improper Referencing: Cite all necessary sources.
W14V4M29	Reason 5: Badly presented manuscript:
W14V4M30	· Referees and editors cannot understand the work:
W14V4M31	· Contains unclear descriptions of what was done.
W14V4M32	· Figures and tables are difficult to follow.
W14V4M33	Rejection ≠ Rejection:
W14V4M34	Separating "scientific soundness" from "interest levels".
W14V4M35	Scientific soundness.
W14V4M36	Results are not sound.
W14V4M37	Interpretation is fundamentally flawed.
W14V4M38	Ethical concerns.
W14V4M39	--> Manuscript cannot be published (in its current form).
W14V4M40	Interest levels:
W14V4M41	Not in scope for this journal.
W14V4M42	Not a big advance.
W14V4M43	Not of interest to this journal's readership.
W14V4M44	--> Manuscript suitable for a more specialized journal --> Transfer offered
W14V4M45	Reasons for rejection:
W14V4M46	Peer-review cascade (example):
W14V4M47	Breast Cancer Research Impact Factor 5.87 --> High rejection rate.

W14V4M48	BMC Cancer Impact Factor 3.33 --> Moderate rejection rate.
W14V4M49	BMC Research Notes --> Low rejection rates.
W14V4M50	Transfer of reviewers' reports:
W14V4M51	· Avoids delays for authors.
W14V4M52	· Avoids wasting the time of peer reviewers.
W14V4M53	· Separates scientific soundness of research from level of interest.
W14V5M1	Get your research published: writing a good MS.
W14V5M2	Some publishers have a Central Author Academy.
W14V5M3	Check journal-specific policies and instruction for authors!
W14V5M4	Utilize the publisher's template and follow directions!
W14V5M5	Check journal's editorial policies.
W14V5M6	Attention: Title:
W14V5M7	· Specific and short.
W14V5M8	· Broad appeal: avoid unnecessary detail.
W14V5M9	· Avoid abbreviations.
W14V5M10	· Reviewers and editors will ask whether the title accurately reflects on the content of the manuscript.
W14V5M11	· Consider keywords!
W14V5M12	A good title will help attract readers and citations.
W14V5M13	Attention: Abstract:
W14V5M14	· Specific information about:
W14V5M15	- Aim(s) of the study.
W14V5M16	Why are the questions important?
W14V5M17	- Main methods and materials used.
W14V5M18	- Key results presented and
W14V5M19	- Conclusions drawn.
W14V5M20	· Bear indexing and searching in mind:

W14V5M21	Use keywords that will attract readers.
W14V5M22	· A badly written and unclear abstract might mean:
W14V5M23	- that the editor misses the importance of the work.
W14V5M24	- that invited referees decline to review the manuscript
W14V5M25	Attention: Figures, tables AND their legends!
W14V5M26	· Main results and data should be shown with illustrations: many readers (and editors!) will look at the figures and tables without reading the whole article.
W14V5M27	· Figure layout is clear and logical (e.g. top to bottom or clockwise arrangement depending on journal template).
W14V5M28	· All components in the figure labeled and described in the legend. The labels match the figures.
W14V5M29	· Enough detail in the legend for readers to understand what type of data and analyses are presented and what the key results are.
W14V5M30	· The figure is referenced in the text!
W14V5M31	· Also the figure appears after it is mentioned in text.
W14V5M32	· Science is often complex: use simple language.
W14V5M33	· Ask your colleagues for feedback.
W14V5M34	· Have them review and edit your publication.
W14V5M35	· Ask adviser to conduct a final critical review.
W14V5M36	· Have critical language edits from KAIST Language Center.
W14V5M37	· Read your article again, ensure it makes sense.
W14V6M1	Get your research published: Planning ahead:
W14V6M2	Key sections in research articles reflect the scientific method:
W14V6M3	· Background
W14V6M4	· Methods and materials
W14V6M5	· Research/data

W14V6M6	· Discussion/interpretation
W14V6M7	· References
W14V6M8	Experimental design - get it right:
W14V6M9	Background:
W14V6M10	· What is your hypothesis or research question?
W14V6M11	· What are the aims of your study?
W14V6M12	Methods and materials:
W14V6M13	· Which methods are appropriate to answer your questions?
W14V6M14	· Do you need ethics approval and/or patient consent?
W14V6M15	· Do you need to register a clinical trial?
W14V6M16	Research/data:
W14V6M17	· Are the sample sizes (n) large enough?
W14V6M18	· What are the right controls?
W14V6M19	· Which statistical test?
W14V6M20	· Utilize best practice.
W14V6M21	Get your research published: Before you start writing...
W14V6M22	What is a valuable contribution?
W14V6M23	· New and original results or methods/tools.
W14V6M24	· Reanalysis or reinterpretation of published date.
W14V6M25	· Meta-analysis.
W14V6M26	· Review articles on a particular subject.
W14V6M27	· Negative results can be of value too.
W14V6M28	You should not knowingly publish:
W14V6M29	· Work that is out of date or does not add new information.
W14V6M30	· Flawed or manipulated data.
W14V6M31	· Duplication or previously published work.

W14V6M32	Publication and research ethics:
W14V6M33	· Plagiarism
W14V6M34	· Improper author contribution
W14V6M35	· Data fabrication and falsification
W14V6M36	· Improper use of human subjects and animals
W14V6M37	Consequences of unethical behavior:
W14V6M38	· Unable to publish in the future.
W14V6M39	· (Some) journals ban authors.
W14V6M40	· Loss of reputation.
W14V6M41	· Loss of employment.
W14V6M42	· Studies without ethical approval (where needed) are rejected.
W14V6M43	Publication and research ethics guidelines:
W14V6M44	· ICMJE: International Committee of Medical Journal Editors.
W14V6M45	· CONSORT: Consolidated Standards of Reporting Trials.
W14V6M46	· COPE: Committee on Publication Ethics.
W14V6M47	· WMA Declaration of Helsinki.

Chapter 9: Appendix Three

Quiz Items

Top of Form: Quiz 1

Video title: Introduction Section

1. What do you call something not covered by the scope of your paper?

- limitation
- boundary
- error

Video title: Introduction Section

2. Which of the following may be a function of the Introduction section?

- Giving the reader background on the topic of the research.
- Describing the limitations of the study.
- Describing the findings of the study.
- Discussing future research on the topic of the study.

Video title: Introduction Section

3. What do the Introduction and Conclusion sections have in common?

- They discuss the topic in a rather broad manner.
- They discuss future research on the topic.

- [ ] They may discuss limitations of the study.

- [ ] They both discuss the implication of the findings.

Video title: Overview of Scientific Writing

4. According to surveys, successful scientists and engineers spend 25% of their time doing what?

- [ ] Writing

- [ ] Making phone calls

- [ ] Reading

- [ ] Listening

Video title: Overview of Scientific Writing

5. At the end of the semester, you will present your work to your classmates in this class. Which of the following **best** describes the type of audience you will be presenting to?

- [ ] A biased audience

- [ ] General technical audience

- [ ] Audience from different fields

- [ ] Specific technical audience

Video title: Overview to Scientific Writing

6. What type of audience were mentioned in the lecture?

- [ ] Non-technical audience
- [ ] Specific technical audience
- [ ] Highly technical audience
- [ ] General technical audience
- [ ] General audience

Video title: Downloading Journal Templates

7. Under which heading would you find the journal template on a journal website?

- [ ] Contacts
- [ ] Subscriptions
- [ ] Editorial board
- [ ] Guide for authors

Video title: Downloading Journal Templates

8. Which is NOT a reason why you should download journal templates?

- [ ] It is necessary to understand requirements for a journal.
- [ ] All the journals out there follow the same format.
- [ ] It is better to start with what the journal requires at the beginning.

- [ ] Templates are helpful suggestions.

Video title: Conquering the Comma

9. Which of the following sentences makes most sense?

- [ ] I like pizza which has been baked in a brick oven over a wood fire.
- [ ] I like pizza that has been baked in a brick oven over a wood fire.
- [ ] I like pizza which is a dish that originated in ancient Rome.
- [ ] I like pizza that is a dish that originated in ancient Rome.

Video title: Verb Tense

10. We should use present tense to do what?

- [ ] Describe our experimental procedures and findings.
- [ ] State what we did in the past.
- [ ] State general information.
- [ ] State what is happening while you are reading the paper (e.g., Figure 1 shows...).

Video title: Verb Tense

11. What verb tense is usually used in the first sentence of the Introduction Section?

Hint: The first sentence of the Introduction Section usually has the word "recently."

- [ ] Present tense
- [ ] Past tense
- [ ] Present perfect tense
- [ ] Past perfect tense
- [ ] Future tense

Video title: Verb Tense

12. Which of the following are reasons to use present tense?

- [ ] It is reader-friendly.
- [ ] It is the default tense in English, meaning that it will always be understood in any situation.
- [ ] It is suitable to explain truths and facts.
- [ ] It is suitable to express things that occur during the reading of the paper.

Video title: Word choice

13. Select an acceptable replacement for the italicized word in the sentence below. Select all that apply.

The authors gratefully acknowledge J. Smith for her ***good*** suggestions.

- [ ] useful

helpful

occasional

possible

Submit

Bottom of Form: Quiz 1

Top of Form: Quiz 2

Video title: Writing with Acronyms

1. Which is correct?

☐ Acronym can be used only once in every paragraph of section.

☐ Never use acronyms in Acknowledgements section.

☐ Acronyms should be defined before they are used. For example, you can say the Korea Advanced Institute of Science and Technology (KAIST), not the other way around.

☐ Don't use acronyms in the title of paper, unless they are well known.

Video title: Writing with Acronyms

2. Which of the following acronym options are correct?

☐ KAIST (Korea Advanced Institute of Science and Technology) is an outstanding university.

☐ Dude, you can just say fosho (for sure).

☐ The Colorado School of Mines (CSM) is in Golden, Colorado.

☐ The Republic of Korea (ROK) is a country of 50 million people.

Video title: Countable vs. Noncountable Nouns

3. Which of the following statements is correct?

☐ Information-related words (e.g., research, work, knowledge, data) are usually uncountable.

☐ Countable nouns are discrete, so they can be counted.

☐ Mass (collective) nouns are uncountable and need a counting unit to count.

☐ Countable nouns can be counted using numbers and have a singular and a plural form.

Video title: Countable vs. Noncountable Nouns

4. Are *capacity*, *equipment*, *space*, and *storage* usually countable or uncountable? Why?

☐ Countable. They are discrete like sand.

☐ Countable. You can count them all like research and work.

☐ Uncountable. They can be preceded by the word much.

☐ Uncountable. Each word is indiscrete or abstract like love and knowledge.

Video title: Countable vs. Noncountable Nouns

5. Which of the following is countable?

☐ Information

☐ Finding

☐ Study

- [ ] Task

Video title: Countable vs. Noncountable Nouns

6. What are some ways to know whether a noun is uncountable?

- [ ] You don't want to or can't count it.

- [ ] It is not discrete. It is treated as a collective entity.

- [ ] It is discrete.

- [ ] It is massive.

Video title: Countable vs. Noncountable Nouns

7. The word "research" is countable. Why or why not? Explain your reasoning.

- [ ] It is countable because you get many hits when you look for "researches" on Google.

- [ ] It is countable in English because it is in Korean.

- [ ] It is uncountable because the word "research" doesn't seem to be a discrete unit of something.

- [ ] None of the other options

Video title: Countable vs. Noncountable Nouns

8. Which word is a countable alternative for the uncountable word "work"?

- [ ] Task

- [ ] Homework
- [ ] force-times-displacement
- [ ] I don't know.

Video title: Plagiarism

9. Which type of plagiarism involves proper citation of sources but no original content from the student?

- [ ] The Aggregator
- [ ] The Hybrid
- [ ] The Clone
- [ ] The Remix
- [ ] The Retweet

Video title: Plagiarism

10. The Clone form of plagiarism involves copying how much (e.g., percentage) of someone else's work?

Choose all that apply.

- [ ] 100%
- [ ] 10%
- [ ] 50%

0%

Submit

Bottom of Form: Quiz 2

Top of Form: Quiz 3

Video title: Complexity

1. Which of the following statements is correct?

☐ It is fine for journal papers to be complex to prevent others from copying your work.

☐ Jargon must be included as much as possible to make papers as complex as possible.

☐ It is fine to go beyond the threshold level for the sake of simplicity

☐ Technical terms, if possible, should be replaced with simple words.

Video title: Complexity

2. Which of the following statements about the Gunning Fog Index is correct?

☐ It is an index measuring the complexity.

☐ Complexity depends on the lengths of sentences and words.

☐ $F_i = 0.4((N_w/N_s)+P_{lw})$

☐ None of the other options

Video title: Complexity

3. Which of the following statements is correct?

- [ ] Papers need to complex so they are only accessible to experts.
- [ ] Papers need to be simpler to allow even children to access them.
- [ ] It is important to keep papers from being unnecessarily complex
- [ ] "Everything should be made as simple as possible, but not simpler." - Albert Einstein

Video title: Complexity

4. Which of the following statements is correct? Select all that apply.

- [ ] You should replace technical terms with simple words whenever possible.
- [ ] An article should not include any jargon since it should be read by everyone.
- [ ] Jargon refers to a lexicon for the average person.
- [ ] Jargon refers to technical terms used in particular professions.

Video title: Complexity

5. What encouraged Gunning to create the Gunning Fog index?

- [ ] He thought academic writing is unnecessarily easy.

- [ ] Academic writing should be more accessible to common people.
- [ ] He thought academic writing should be limited to highly educated people
- [ ] Common people should not have access to academic writing

Video title: Complexity

6. Which of the following statements is correct?

- [ ] Single and double quotation marks have equivalent usage in both Korean and English.
- [ ] In Korean, single quotation marks are used to repeat someone's exact words.
- [ ] In English, single quotation marks are used to express paraphrases.
- [ ] None of the other options

Video title: Quotes 1

7. Which of the following sentences are correctly punctuated? Select all that apply.

- [ ] It was Albert Einstein who said, "Make everything as simple as possible, but not simpler."
- [ ] The teacher asked, "Who said, 'Make everything as simple as possible, but not simpler'?"
- [ ] I did not know it was Einstein who said, 'make everything as simple as possible, but not simpler.'

☐ None of the other options

Video title: Quotes 1

8. Which of the following sentences are correctly punctuated? Select all that apply.

☐ “I should have done it,” Andres said, “But I did not have enough time.”

☐ “I was very excited about the Rio Olympics,” Maria sighed, “but it was far below my expectations.”

☐ Matthew claimed that “Hanhwa Eagles will eventually win” because they are on a winning streak.

☐ Cruz shouted, “I am telling you, ‘It ain’t over till it’s over,’ as Yogi said!”

Video title: Quotes 1

9. Which of the following statements are correct? Select all that apply.

☐ For indirect quotations, you should not use quotation marks.

☐ Sometimes quotation marks are necessary for indirect quotations.

☐ When both direct quotations and indirect quotations are used together, put quotation marks for both quotes

☐ Indirect quotations are paraphrased direct quotations

Video title: Quotes 1

10. Which of the following statements are correct? Select all that apply.

- [ ] Ellipsis are used to signify the words in the quotation that are left out.
- [ ] Double quotations are used to identify direct quotations only.
- [ ] Indirect quotations are identified by single quotations.
- [ ] Brackets are used for additional words that are inserted for clarification.

Video title: Quotes 2

11. Which of the following statements is correct?

- [ ] Quotation marks are used to indicate ironic words.
- [ ] Quotation marks are used to indicate sarcastic words.
- [ ] Quotation marks are used to indicate doubtful words.
- [ ] None of the other options

Video title: Quotes 2

12. Which of the following statements is correct?

- [ ] Italics are used when unfamiliar, technical terms are introduced for the first time.
- [ ] Italics are used to identify titles of minor works such as songs and short stories
- [ ] Italics are used to identify titles of parts of larger works such as chapters of a book and episodes of TV series

☐ None of the other options

Video title: Quotes 2

13. Which of the following statements is correct?

☐ A colon can be used to introduce a list of items in a sentence

☐ A colon cannot exist in between quotation marks

☐ A colon is part of a dialogue tag introducing a quote.

☐ Quotation marks are still necessary when a colon is used to introduce a dialogue tag and a quote

Video title: Quotes 2

14. Which of the following sentences is correctly punctuated?

☐ There is a proverb that states, “Treat others as you want to be treated”.

☐ Kim, criticizing North Korea, stated, “It is impossible to last another generation” [3].

☐ I thought you have “studied”. What happened to your grade?

☐ None of the other options

Video title: Quotes 2

15. Which of the following sentences are punctuated correctly? Select all that apply.

☐ McGregor emphasized two elements in “winning a fight”: precision beats power and timing beats speed.

☐ President Park proclaimed that her academic policy for the school was “an enormous success;” all students disagreed.

☐ Psy asked the audience, “Do you want another song?”

☐ Jane shouted enthusiastically, “Unbelievable!”

Submit

Bottom of Form: Quiz 3

Top of Form: Quiz 4

Video title: Complexity

1. Which of the following statements is correct?

☐ It is fine for journal papers to be complex to prevent others from copying your work.

☐ Jargon must be included as much as possible to make papers as complex as possible.

☐ It is fine to go beyond the threshold level for the sake of simplicity

☐ Technical terms, if possible, should be replaced with simple words.

Video title: Complexity

2. Which of the following statements about the Gunning Fog Index is correct?

☐ It is an index measuring the complexity.

☐ Complexity depends on the lengths of sentences and words.

☐ $F_i = 0.4((N_w/N_s)+P_{lw})$

☐ None of the other options

Video title: Complexity

3. Which of the following statements is correct?

- [ ] Papers need to complex so they are only accessible to experts.
- [ ] Papers need to be simpler to allow even children to access them.
- [ ] It is important to keep papers from being unnecessarily complex
- [ ] "Everything should be made as simple as possible, but not simpler." - Albert Einstein

Video title: Complexity

4. Which of the following statements is correct? Select all that apply.

- [ ] You should replace technical terms with simple words whenever possible.
- [ ] An article should not include any jargon since it should be read by everyone.
- [ ] Jargon refers to a lexicon for the average person.
- [ ] Jargon refers to technical terms used in particular professions.

Video title: Complexity

5. What encouraged Gunning to create the Gunning Fog index?

- [ ] He thought academic writing is unnecessarily easy.

- [ ] Academic writing should be more accessible to common people.
- [ ] He thought academic writing should be limited to highly educated people
- [ ] Common people should not have access to academic writing

Video title: Complexity

6. Which of the following statements is correct?

- [ ] Single and double quotation marks have equivalent usage in both Korean and English.
- [ ] In Korean, single quotation marks are used to repeat someone's exact words.
- [ ] In English, single quotation marks are used to express paraphrases.
- [ ] None of the other options

Video title: Quotes 1

7. Which of the following sentences are correctly punctuated? Select all that apply.

- [ ] It was Albert Einstein who said, "Make everything as simple as possible, but not simpler."
- [ ] The teacher asked, "Who said, 'Make everything as simple as possible, but not simpler'?"
- [ ] I did not know it was Einstein who said, 'make everything as simple as possible, but not simpler.'

☐ None of the other options

Video title: Quotes 1

8. Which of the following sentences are correctly punctuated? Select all that apply.

☐ “I should have done it,” Andres said, “But I did not have enough time.”

☐ “I was very excited about the Rio Olympics,” Maria sighed, “but it was far below my expectations.”

☐ Matthew claimed that “Hanhwa Eagles will eventually win” because they are on a winning streak.

☐ Cruz shouted, “I am telling you, ‘It ain’t over till it’s over,’ as Yogi said!”

Video title: Quotes 1

9. Which of the following statements are correct? Select all that apply.

☐ For indirect quotations, you should not use quotation marks.

☐ Sometimes quotation marks are necessary for indirect quotations.

☐ When both direct quotations and indirect quotations are used together, put quotation marks for both quotes

☐ Indirect quotations are paraphrased direct quotations

Video title: Quotes 1

10. Which of the following statements are correct? Select all that apply.

- [ ] Ellipsis are used to signify the words in the quotation that are left out.
- [ ] Double quotations are used to identify direct quotations only.
- [ ] Indirect quotations are identified by single quotations.
- [ ] Brackets are used for additional words that are inserted for clarification.

Video title: Quotes 2

11. Which of the following statements is correct?

- [ ] Quotation marks are used to indicate ironic words.
- [ ] Quotation marks are used to indicate sarcastic words.
- [ ] Quotation marks are used to indicate doubtful words.
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☐ President Park proclaimed that her academic policy for the school was “an enormous success;” all students disagreed.

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Submit

Bottom of Form: Quiz 4

Top of Form: Quiz 5

Video title: Colon and Semicolon

1. Which of the following sentences is correct?

☐ I like to eat: pizza, French fries, and hamburgers.

☐ There are two reasons I cannot meet you tomorrow: I have to finish my homework assignments; I have four classes that I must attend.

☐ I enjoy visiting the beach in the summer; it helps me relax.

☐ My professor suggested that I do the following; keep researching and stop complaining about it.

Video title: Colon and Semicolon

2. Choose the correct statement(s) for the usage of colons and semicolons.

☐ A space must separate both the left and right sides of the colon or semicolon.

☐ Specific information comes before the colon, and the general information comes after.

☐ An equation may be written after a colon, but you are not always restricted to this convention.

☐ A semicolon can be used to join two independent clauses.

Video title: Colon and Semicolon

3. Select grammatically correct sentences.

☐ The data analysis took such a long time; it took us 14 days.

☐ I made Johnny’s favorite dishes: tamales, enchiladas, burritos, tacos, and tortas.

☐ I go to KAIST; therefore, I have no social life.

☐ The results gained wide attention: however, they were later proven to be false.

☐ Last week, I tested five fuel types; bituminous coal, subbituminous coal, PVC, PVA, and char.

Video title: Colon and Semicolon

4. Which of these statements are correct?

☐ A semicolon joins two totally unrelated independent clauses.

☐ The number of items following a colon is restricted to three.

☐ The word “however” in the middle of a sentence follows a semi-colon.

☐ A colon can be used to describe a mathematical equation.

Video title: Colon and Semicolon

5. Which of the following sentences are **incorrect** with regard to the usage of a colon and/or semicolon?

☐ There are two things I do not like about you; your personality and stupidity.

☐ I believe everyone has the right of free speech: however, this right does not mean that you should disregard basic manners when talking to others.

☐ We came up with two new ideas for the project: dividing the work equally among the team members and working at home.

☐ Many people think that renting an apartment is a more attractive option than buying; consequently, rent rates are increasing throughout the city.

Video title: Hyphens

6. Which of these phrases does NOT need to be hyphenated?

☐ Grain boundary sliding

☐ Tip sample interaction

☐ At high frequencies and low amplitudes of excitation

☐ Low frequency high amplitude measurements

Video title: Hyphens

7. Which of the following sentences are INCORRECT in using hyphens?

☐ I hated silica gel-coated-glass-fiber paper chromatography.

☐ He doesn’t want to stay at the football club; he won’t re-sign a new contract.

☐ That is the best song by Mik-Fanguy.

☐ He’s a highly respected scientist.

Video title: Hyphens

8. Which sentences DO NOT require a hyphen?

☐ The Great Wall of China can be seen from the Moon.

☐ The medication is fast acting.

☐ Low frequency measurements were recorded.

☐ Rpm increased in the top to bottom direction

Video title: Hyphens

9. Which sentences mean that the furniture is old?

☐ He was an old-furniture salesman.

☐ He was an old furniture salesman.

☐ He was old and sold furniture.

☐ He was an ancient-furniture salesman.

Video title: Hyphens

10. Before which word should a hyphen be placed in order to mean 80 hours total?

He works (a)twenty(b)four(c)hour(d)shifts.

- [ ] twenty
- [ ] four
- [ ] hour
- [ ] shifts

Video title: Paraphrasing

11. Which options are inappropriate for paraphrasing the following sentence?

Several students protested the dean for his insensitive remarks regarding the janitorial staff.

- [ ] Several students were unhappy with the dean’s latest comments.
- [ ] The dean’s insensitive remarks resulted in satisfaction among the students.
- [ ] The janitorial staff was very grateful to the students who protested the dean’s rude comments.
- [ ] The dean’s insensitive remarks regarding the janitorial staff were protested by the students.

Video title: Paraphrasing

12. Which of the following are NOT recommended for paraphrasing?

- [ ] Replace some of the original words with synonyms.
- [ ] Change the original active constructions to passive constructions or vice versa.

☐ Change the words so that the new phrase has the same tone but a different meaning.

☐ Using the same words and phrases as in the original

Video title: Paraphrasing

13. Which of the following options are true regarding paraphrasing?

☐ Information can be copied word for word.

☐ You use the same words and phrases.

☐ Paraphrase is generally the same length or slightly shorter than the original source.

☐ The new phrase should not have a completely different meaning from the original.

Video title: Paraphrasing

14. Choose the best paraphrase of the following:

In general, female birds are less colorful than male birds.

☐ In general, male birds are more attractive than female birds.

☐ On the whole, the feathers of the female birds are not as striking as those of their counterparts.

☐ It’s often the case that birds that are female are more colorful than male birds.

☐ Generally speaking, female birds are less colorful than male birds.

Video title: Paraphrasing

15. Choose the best paraphrase for the following:

Living aboard a space station in orbit around Earth for months at a time poses problems for astronauts' bodies as well as their minds.

- An Article in *Space Science* magazine reports that lengthy space station duty may lead to physical and mental problems for astronauts.
- An article in *Space Science* magazine reports that astronauts who live aboard space stations for a month may experience physical as well as mental problems.
- An article in *Space Science* reports that living in a space station orbiting Earth for a long time can cause difficulties for astronauts' bodies and minds.
- An article in *Space Science* reports that an astronaut will become physically sick and have mental problems if they visit a space station.

Video title: Unclear Pronoun Reference

16. Complete the following sentence:

If you find an ambiguous pronoun in one of your sentences,

- it is usually best to restate the antecedent.
- it's usually best to leave the sentence as it is.
- it's usually best to have two antecedents.

☐ You can replace the ambiguous pronoun with another word that has the same meaning as the antecedent.

Video title: Unclear Pronoun Reference

17. Which of the following statements is inadvisable in terms of pronoun usage?

☐ One of my colleagues is sick now, so I should cover for him.

☐ Our boss asked us to raise our standards.

☐ If it’s available, please order a club sandwich for me.

☐ When I’m with my best friends, I can speak my mind to them.

Video title: Unclear Pronoun Reference

18. Which of the following statements are correct in terms of pronoun usage?

☐ I met Jack and Tim last night to celebrate their birthday. They have the same birthday by the way.

☐ Our lab is equipped with a microscope, a high-speed camera, and a syringe pump. It is worth 1 million won.

☐ Inorganic acids should be separated from other chemicals, so we should move them to another place.

☐ Our professor expects us to try our very best on the upcoming research project.

Video title: Unclear Pronoun Reference

19. Among the following, which is not a pronoun?

- [ ] Each
- [ ] They
- [ ] However
- [ ] How

Video title: Unclear Pronoun Reference

20. Which of the following are not problematic in English writing?

- [ ] Ambiguous pronoun
- [ ] Faraway antecedent
- [ ] Missing antecedent
- [ ] Multiple first-person pronouns (singular and plural)
- [ ] Third-person pronoun

Submit

Bottom of Form: Quiz 5

Top of Form: Quiz 6

Video title: Results Overview

1. What are the three purposes that the sentences from the results section mainly serve?

☐ Explanation, comparison, and introduction

☐ Comparison, generalization, and abstraction

☐ Abstraction, generalization, and conclusion

☐ Explanation, comparison, and generalization

Video title: Results Section - Language Conventions & Informational Elements

2. Which of the following phrases serves a purpose different from the other three?

☐ It appears that hyperactive children are responsive to amphetamines.

☐ Dense network nodes may be correlated with slow network performance.

☐ These results suggest that children who display learning problems are depending on only one cerebral hemisphere.

☐ The battery lifetime was extended 23% compared to previous attempts.

Video title: Results Section - Language Conventions & Informational Elements

3. Which phrase conveys the weakest emphasis of a result?

☐ Significantly lower than

- [ ] Far more power-efficient than
- [ ] Remarkably faster than
- [ ] Better than

Video title: Illustration

4. What is the main purpose of Gantt charts?

- [ ] To compare parts of a whole
- [ ] To compare elements of different sizes
- [ ] To show activities and events against time
- [ ] To list different measurements

Video title: Illustration

5. Which is the main advantage of using photographs?

- [ ] Realism
- [ ] Control of detail
- [ ] Ability to show flow of a variable through a system
- [ ] None of the other options

Video title: Writing with Numbers

6. When you write a sentence that has two numbers located next to one another...

- [ ] Write the first one as a numeral and the second one as a word.
- [ ] Write the first one as a word and the second one as a numeral.
- [ ] Write both of them as a numeral.
- [ ] Write both of them as words.
- [ ] Try to avoid putting two numbers next to one another.

Video title: Writing with Numbers

7. Which of the following sentences is correct in terms of writing with numbers? You may select more than one option.

- [ ] 2 apples, three oranges, and five bananas were enough fruit for the class.
- [ ] 6% of the class failed.
- [ ] The club celebrated the birthdays of five 90-year-olds who were born in the city.
- [ ] According to the survey, people generally slept seven and a half hours every night.

Video title: Writing with Numbers

8. If you find that you have started a sentence with a numeral...

(choose all that apply)

- [ ] It is OK.

- [ ] Write the numeral in words.
- [ ] Revise the sentence so that the numeral comes later.
- [ ] Turn the sentence into an equation.

Video title: Writing with Numbers

9. Which of these is an INCORRECT way of writing numbers?

- [ ] Figure three illustrates the relation between velocity and energy.
- [ ] The government still has to pay $35,600.
- [ ] A more detailed explanation is provided on page 6.
- [ ] Over the past decade, life expectancy increased by 4%.

Video title: Writing with Numbers

10. When writing with numbers in a journal article, which rule should you follow?

- [ ] Write numbers one through nine as words, and 10 and higher as numerals.
- [ ] Write numbers one through one hundred as words, and numbers above that as numerals.
- [ ] Follow the conventions given in the journal style guide or template.
- [ ] Always write numbers in numeral form.

☐ Write numbers in words or numerals, depending on your audience (including your journal template).

Video title: Writing with Numbers

11. Which of the following are exceptions to the general rules for writing with numbers and, therefore, should be written as numerals?

☐ Non-whole numbers (e.g., 3.1).

☐ Number of people or animals (e.g., 3 doctors and 3 nurses).

☐ Page numbers (e.g., page 2).

☐ Figure number (e.g., Figure 2).

Video title: Writing with Numbers

12. Which among the following is the correct way to use as numbers? Select all that apply.

☐ Different types of landslides occur. 2 types among them are the most dangerous.

☐ The velocity of the car is 42 m/s.

☐ Seventeen percent of area exists under water.

☐ Astronomers observed fourteen five moon planets.

Submit

Bottom of Form: Quiz 6

Top of Form: Quiz 7

Video title: Discussion Section - Overview

1. Which of the following is generally not included in the discussion section?

- Limitations
- Further research / possible applications & implications
- Details of results by other researchers
- Original hypothesis
- Summary of the research

Video title: Discussion Section – Modal Verbs

2. Choose inappropriately paraphrased sentences of the following: "We felt sure the damage was caused by heat exposure."

- The damage cannot have been caused by heat exposure.
- The damage should not have been caused by heat exposure.
- The damage could have been caused by heat exposure.
- The damage must have been caused by heat exposure.

Video title: Discussion Section – Modal Verbs

3. What can you infer about modal verbs from the following sentences?
He cans has a cheeseburger. (X) He can have a cheeseburger. (O)

☐ Modal verbs do not have subject-verb agreement.

☐ Modal verbs do not require a “to” before the infinitive-form verb following the modal.

☐ Some modal verbs change meaning in their negative form.

☐ None of the other options

Video title: Discussion Section – Modal Verbs

4. What can you infer about modal verbs from the following sentences?
He would to prefer the first option. (X) He would prefer the first option. (O)

☐ Modal verbs do not have subject-verb agreement.

☐ Modal verbs do not require a “to” before the infinitive-form verb following the modal.

☐ Some modal verbs change meaning in their negative form.

☐ None of the other options

Video title: Discussion Section – Modal Verbs

5. What can you infer about modal verbs from the following sentences?
“You must go home.” is equivalent to “You have to go home.”
“You must not go home.” is ***not*** equivalent to “You do not have to go home.”

☐ Modal verbs do not have a subject-verb agreement.

☐ Modal verbs do not require a “to” before the infinitive-form verb following the modal.

- [ ] Some modal verbs change meaning in their negative form.
- [ ] None of the other options

Video title: Discussion Section – Modal Verbs

6. Which “cannot” has been used inappropriately?

- [ ] This cannot only damage the sample; it may even destroy it completely.
- [ ] We realize that this cannot be due to a change in pressure.
- [ ] I cannot focus on my work if there is too much noise around me.
- [ ] Every “cannot” above has been used appropriately.

Video title: Discussion – Components

7. Relating your work to previous works and/or the current state of the field is called:

- [ ] Mapping
- [ ] Refining the implications
- [ ] Limitations
- [ ] Summarizing

Video title: Discussion – Components

8. Which of the following sentences is an example of a limitation?

☐ The global observations used in our study confirm this trend, but the industry improvements have been offset by increased natural-gas production.

☐ Accounting for previously neglected FFgeo, our correction of 20%–60% higher CH4 emissions from natural gas, oil and coal production and use implies a greater potential for industry efficiency improvements to mitigate anthropogenic climate forcing.

☐ Our finding that FF CH emissions are 60%–110% higher than previous studies based on the most comprehensive global database compiled so far represents a major adjustment in the globalCH4 budget, and this is consistent with the observed latitudinal CH4 gradient.

☐ The ray acoustics model used in our study is only applicable when the wavelength is smaller than the droplet diameter.

Video title: Discussion – Overview

9. The discussion section can be most closely correlated with the content of …

☐ the Appendix

☐ the Introduction section

☐ the Abstract

☐ the Methodology section

Video title: Discussion – Overview

10. The discussion section should not:

- [ ] summarize the data from your work
- [ ] introduce the reader to the importance of your work
- [ ] highlight the implications of your results
- [ ] describe what protocols were used to conduct the study

Video title: Discussion – Overview

11. Which of the following sentences is unlikely to be found in the discussion section?

- [ ] A total of twelve students participated in the study.
- [ ] Recent studies show an alarming increase in the cholesterol levels of the average student.
- [ ] Fifteen percent of students displayed decreased cholesterol levels in response to the administered drug.
- [ ] Future work should examine the amount of sleep as an early indicator of rising cholesterol levels.

Video title: Discussion – Overview

12. Which of the following sentences is unlikely to be found in the discussion section?

- [ ] Most carcinoma cells disseminated with a mesenchymal morphology (60%) as they protruded into the ECM and maintained an elongated morphology while migrating through the collagen I matrix.

☐ Cancer is a genetic disease, and sequencing has revealed that genes encoding cell–cell and cell–matrix adhesion proteins frequently are mutated.

☐ A major challenge today is to distinguish the relative contributions of specific genetic and microenvironmental changes to the migration and local dissemination of carcinoma cells.

☐ Because the collective migration strategy of epithelial cells differs in different ECMs, it also is possible that specific genetic perturbations contribute to invasion and dissemination only in specific microenvironmental contexts.

Video title: Discussion – Overview

13. Which of the following sentences is unlikely to be found in the discussion section?

☐ False-belief understanding is of particular interest because it requires recognizing that others' actions are driven not by reality but by beliefs about reality, even when those beliefs are false.

☐ For nearly four decades, a cardinal question in psychology has concerned whether nonhuman animals, such as great apes, also possess this cognitive skill.

☐ Differential performance between tasks may reflect differences in task demands or context, or less flexible abilities in apes compared with humans.

☐ During the belief-induction phase, the agent witnessed the initial hiding of the object, but the object was then moved to a second location while the agent was either present or absent.

Discussion Section – Researcher's position

14. Which of the following statements is correct for the Discussion section?

- [ ] The writer revisits previous research.
- [ ] The writer revisits the Introduction to recall specific weakness in the methodology used in previous studies.
- [ ] The writer revisits the methodology used in this study.
- [ ] The writer revisits and summarises the results.
- [ ] The writer shows where and how the present work fits into research 'map' of this field.

Video title: Discussion Section - Modal Verbs

15. Which of the following modal verbs is used to express virtual certainty?

- [ ] must
- [ ] cannot
- [ ] should
- [ ] would
- [ ] ought to

Video title: Discussion/Conclusion - Modal Verbs

16. Which of the following modal verbs is used to express probability/belief/expectation?

- [ ] should have
- [ ] should
- [ ] can
- [ ] cannot
- [ ] must

Video title: Discussion Section – Researcher’s Position

17. Which of the following sentences is appropriate for the discussion and conclusion section?

- [ ] The presence of such high levels is a novel finding.
- [ ] We identified dramatically different profiles in adult lungs.
- [ ] Our study provides the framework for future studies to assess the performance characteristics.
- [ ] Our results provide a clear distinction between the functions of the pathway proteins.
- [ ] We aim to investigate the underlying principles of the droplet breakup phenomenon.

Video title: Discussion Section – Researcher’s Position

18. Which of the following sentences is appropriate for the discussion and conclusion section?

We have made the surprising observation that Bro1-GFP focus accumulation is also pH-dependent.

We have derived exact analytic expressions for the percolation threshold.

Our data rule out the possibility that this behavior was a result of neurological abnormality.

Our results provide compelling evidence that this facilitated infection.

These preliminary results demonstrate the feasibility of using hologram-based RI detectors.

Submit

Bottom of Form: Quiz 7

Top of Form: Quiz 8

Video title: Active and Passive Voice

1. Which of the following sentences uses the passive voice?

☐ To prevent solidification of our mixture, a softener was added to it.

☐ Lubrication materials were utilized to prevent damage to the structure.

☐ Alcohol contents, despite only trace amount existing, caused the explosion.

☐ The release of HGO-1 hormone has raised the concentration level in a mouse under extreme stress.

Video title: Active and Passive Voice

2. Which of the following sentences uses the active voice?

☐ Milk has been traditionally used to cure viral diseases.

☐ MATLAB had been used to program our product, but it was replaced by Mathematica this year.

☐ His background knowledge in physics had assisted his research in metamaterials.

☐ We must use chemically inert materials to prevent this substance from exploding.

Video title: Active and Passive Voice

3. Which of the following is NOT an appropriate description of the passive voice?

- ☐ The performer of the action is often unknown, irrelevant, or obvious.
- ☐ The passive voice tries to emphasize what was done, not who has done it.
- ☐ The passive voice allows easier control of sentence structure.
- ☐ The passive voice explains things more appropriately and without ambiguity.

Video title: Active and Passive Voice

4. Which of the following is NOT an appropriate description of the active voice?

- ☐ Active voice sentences are usually longer than those written in the passive voice.
- ☐ The active voice is less prone to abusive normalization than the passive.
- ☐ Active voice sentences are generally preferred by journals.
- ☐ Active voice sentences use fewer personal pronouns than passive voice ones.

Video title: Conclusion

5. Researchers may use different modal verbs in the Conclusion Section to indicate the different levels of certainty of their research findings. Which of the following modal verbs is used when the author(s) feels sure about his or her statements?

- must
- must not
- may
- should

Video title: Conclusion

6. Which one of the following statements is correct for the Conclusion section?

- It should contain some explanation of the significance of the present paper.
- It should revisit key results of the study.
- It should provide the details of the method used in the study.
- It should summarize previous research related to the study.
- It should provide the details of the methods used in the related studies.

Video title: Conclusion

7. Which sentence is unlikely to appear in the Conclusion Section?

- The significance of the research findings lies in the practical medicinal applications of the proposed technique.
- One notable theoretical implication of the present paper is the assumption that D does not have to hold true if certain specific conditions are manipulated accordingly.

Through multiple methods of verification, we found that certain molecular behavior cannot be explained with the existing model.

The final step is to record the data on a spreadsheet and add a best-fit regression line.

Video title: Language 1

8. Which of the following sentences is appropriate for use in a scientific paper?

This study will consider why current solar systems, such as Solar One, have not reached the commercial stage and will find out what steps we can take to make these systems commercial.

The goal of this study is to develop a commercialization strategy for solar energy systems by analyzing factors impeding early commercial projects and by identifying the potential actions that can facilitate the viability of the project

This study focuses on the development of a highly efficient solar energy system.

Through analysis of factors that impedes early commercial projects and identification of potential actions that facilitates the viability of the project, we will demonstrate the strategies why current solar energy development for commercialization.

Video title: Language 1

9. Which of the following sentences is inappropriate for use in a scientific paper?

☐ Geo One is a 20 megawatt geothermal electric central receiver Phoenix power pilot plant.

☐ Geo One is a geothermal pilot plant located near Phoenix, Arizona. It produces 20 megawatts of electricity by capturing geothermal energy in a central receiver design.

☐ The construction of Geo One, a 20 megawatt geothermal electric central receiver power pilot plant in Phoenix, will provide green recyclable renewable permanent energy.

☐ During the construction of Geo One, geothermal electric central receiver power pilot capabilities were considered.

Video title: Language 2

10. Which of the following sentences is inappropriate for use in a scientific paper?

☐ We examined neat methanol, ethanol, and methanol and ethanol with 10% water.

☐ For our examination, we utilized methanol with water, ethanol and methanol each, ethanol with water.

☐ Our purpose was to examine four types of solvents: pure methanol, pure ethanol, 10% water-added methanol, and 5% water-added methanol.

☐ To understand the effect of different solvents, we analyzed methanol, ethanol, and their mixture with 10% water, respectively.

Video title: Language 2

11. Which of the following sentences is inappropriate for use in a scientific paper?

☐ Vibration measurements made in the course of the Apollo flight test program were complicated by the presence of intense high-frequency excitation of the vehicle shell structure during the re-entry phase of the flight.

☐ The presence of intense high-frequency excitation of the vehicle chassis, which has a shell structure, will complicate the vibration measurements during the flight test program of Apollo.

☐ Intense high-frequency excitation of the vehicle shell during the re-entry will complicate the vibration measurements inside the Apollo flights.

☐ During the re-entry, the intense high-frequency excitation of the vehicle shell structure will be preset, complicating the vibration measurements in the course of the Titan flight test program.

Submit

Bottom of Form: Quiz 8

Top of Form: Quiz 9

Video title: Abstract

1. Which of the following statements are **incorrect**?

☐ Abstracts are usually between 500 and 1000 words and consist of a single paragraph.

☐ Abstracts are the most commonly read part of the paper.

☐ Abstracts tell us what the research was about and what the conclusion was, and it omits the details.

☐ Abstracts, in general, should answer the following four questions: What did you do? What did you find? Why was that important? If given the opportunity, would you have conducted the experiment differently?

☐ Frequently, students forget to answer the question "Why is that important?" in their abstracts.

Video title: Abstract

2. How can you improve your own ability to write an abstract?

☐ Examine abstracts published in prestigious journals.

☐ Practice writing long sentences in your abstract.

☐ Only state why you did your research.

☐ Receive comments and feedback from professionals, including your adviser.

- [ ] Use complex words and sentences.

Video title: Appendix, Key words, Glossary and Citation

3. What is the use of an Appendix?

- [ ] to include nonessential materials

- [ ] to supply background for secondary audiences

- [ ] to supply secondary or tangential information to primary readers

- [ ] To bolster the manuscript in order to meet the minimum word count.

Video title: Appendix, Key words, Glossary and Citation

4. When there is more than one appendix to include, what should you do?

- [ ] Use numbers. For example, you can write Appendix 1, Appendix 2, and so on.

- [ ] Use Roman numerals. For example, you can write Appendix I, Appendix II, and so on.

- [ ] Use different words. You can say Appendix, Index, and so on.

- [ ] Use letters. For example, you can write Appendix A, Appendix B, and so on.

- [ ] Feel free to use Roman numerals and numbers. For example, you can write I. Appendix 1, II. Appendix 2, and so on.

Video title: Appendix, Key words, Glossary and Citation

5. What should you do with the appendixes that you've included?

- [ ] Refer to all of them in your paper.
- [ ] Only refer to some of them.
- [ ] When you refer to them, make the reference clear.
- [ ] Do not refer to them at all in your paper.
- [ ] Make the appendixes long and complex.

Video title: Conference posters

6. Approximately how long should it take in order for a reader to grasp the idea of a conference poster?

- [ ] 10 seconds
- [ ] 5 mins
- [ ] 20 seconds
- [ ] Half an hour
- [ ] There is no such time limitation.

Video title: Conference Posters

7. How should you capitalize your conference posters?

- [ ] Write the letters in all caps to make your writing more noticeable.

☐ Write the letters in all lowercase to avoid scaring your audience.

☐ Use both capital and lowercase letters, but your style does not have to be consistent.

☐ Use both capital and lowercase letters, and be consistent with your style.

☐ Write in all caps for your title, and write the rest in lowercase.

Video title: Language of Abstract

8. Which of the following guidelines about writing an abstract is **incorrect**?

☐ Try to avoid long sentences such as complex and compound sentences in your abstract.

☐ Try to separate your thoughts into separate sentences.

☐ Make your sentences as long as possible.

☐ Do not put results in your abstract.

☐ Limit the use of commas, semicolons, and colons.

Video title: Language of Abstract

9. What should you do with bibliographic citations in your abstract?

☐ You should include all of them in your abstract. You can avoid plagiarism because people often do not have access to the rest of your paper.

☐ You should include one or two of them so that the readers get a general idea of what your writing is about.

☐ You should never include them. They distract the readers from reading your abstract.

☐ Do not include them. The abstract should only focus on what the paper is about.

☐ Do not include them. The content in the abstract is your own idea.

Video title: Stacked Modifiers

10. Choose the acceptable options to revise the following sentence. Previous work has shown that a purified pro-oxidant, vitamin E-deficient fish oil diet protects mice against malaria parasites.

☐ Previous work shows that a vitamin E-deficient fish oil diet with purified pro-oxidant, protects mice against malaria parasites.

☐ Previous work has shown that feeding a pro-oxidant diet containing fish oil, but devoid of vitamin E, protects mice against malaria parasites.

☐ Previous work has shown that mice can be protected against malaria parasites by consuming a purified pro-oxidant fish oil diet without vitamin E.

☐ None of the other options

Video title: Titles

11. "Bed nets control mosquitoes most effectively when used in a rainy season" is an instance of:

☐ Indicative titles

☐ Informative titles

- [ ] Question-type titles
- [ ] Main-subtitle type titles
- [ ] Hanging titles

Video title: Titles

12. Which of the following are typical functions of the title?

- [ ] Catch the reader’s interest
- [ ] Differentiate your paper from other papers
- [ ] Assist the reader in understanding the field of research
- [ ] Attract the audience to read your paper

Video title: Titles

13. What is the word count of a title?

- [ ] 10 words or fewer
- [ ] 5 words or fewer
- [ ] 20 words or fewer
- [ ] 100 words or fewer
- [ ] There is typically no word count limit. It is totally up to you.

Video title: Titles

14. Titles should contain _____.

- [ ] active verbs
- [ ] noun-based phrases
- [ ] clear, concise words
- [ ] jargon

Submit

Bottom of Form: Quiz 9

Top of Form: Quiz 10

Video title: Choosing a Journal

1. The aims and scope of a journal will enable you to find information about the journal's _____.

- ☐ prestige
- ☐ visibility
- ☐ target readership
- ☐ speed of peer review process

Video title: Choosing a Journal

2. Which does NOT describe a high-threshold journal?

- ☐ A paper's findings are small advances
- ☐ Paper insights are of interest to a specialized group
- ☐ Resources and methods are widely usable
- ☐ Conclusions are strong

Video title: Choosing a Journal

3. Editors often consider the following when reviewing submissions.

- ☐ Novelty of the research proposed
- ☐ Appropriate methodology

- [ ] Logical organization and writing
- [ ] Appropriate scope
- [ ] Prestige of submitting institution

Video title: Choosing a Journal

4. The aim and scope of a journal _____.

- [ ] should be inferred by reading the publication archives
- [ ] often change to adapt to trends
- [ ] can be a deciding factor when accepting or rejecting a submission
- [ ] is less narrow in high impact journals
- [ ] can be ignored if the submitted data is highly revolutionary

Video title: Choosing a Journal

5. You can judge a journal's visibility by _____.

- [ ] entering keywords into Google
- [ ] finding out who the journal's board members are
- [ ] using alternative metrics
- [ ] looking at a journal's aim and scope

Video title: Final Thoughts

6. Which of the following statement/s is correct?

- [ ] A title should be specific and short.
- [ ] It is acceptable to include abbreviations in titles.
- [ ] A title should contain detailed information on the content of the manuscript.
- [ ] A title should be broadly appealing without unnecessary details.

Video title: Final Thoughts

7. Which of the following aspects should be included in an abstract?

- [ ] Affiliation
- [ ] Aim(s) of the study
- [ ] Key results
- [ ] References

Video title: Final Thoughts

8. Which of the following statements is correct?

- [ ] Figures should not be referenced in the text.
- [ ] Figures should appear before they are mentioned in the text.
- [ ] Main results and data should be shown with illustrations.

☐ All components in the figure should be described in the legend.

Video title: Final Thoughts

9. Which of the following statements is correct?

☐ It is recommended to use complex language for a well-written research paper.

☐ It is recommended to ask colleagues for feedback before manuscript submission.

☐ It is recommended to have manuscripts reviewed only by the co-authors.

☐ It is recommended to ask the adviser to conduct a final critical review before manuscript submission.

Video title: Final Thoughts

10. Which of the following statements is incorrect?

☐ Submitting authors should check carefully journal-specific policies and instruction for authors.

☐ Submitting authors should contact editors of their target journal for journal template.

☐ Submitting authors should utilize the publisher’s template and follow their directions.

☐ Submitting authors should use their own template for their convenience.

Video title: Open Access vs. Subscription Journals

11. Which of the following is NOT a characteristic of closed access journals?

- Access that is unlimited to subscribers
- Author transfers copyright to the journal
- Freedom in reusability
- Publisher charges for reprints

Video title: Open Access vs. Subscription Journals

12. Which of the following does NOT accurately describe the differences between the Gold Open Access and Green Open Access?

- Gold OA articles are published in an open access journal, whereas articles Green OA articles are self-archived in an online repository after publication.
- Gold OA articles are available for free to anyone after publication, whereas an embargo period may be applied to Green OA articles.
- Publishing expenses are paid by subscribers with Gold OA, whereas authors pay “article publishing charges” with Green OA.
- Licensing restrictions are less stringent with Gold OA, and Green OA allows flexible licensing options for more author control over his/her work.

Video title: Open Access vs. Subscription Journals

13. Which is the following is/are NOT an advantage of hybrid open access journals?

- High visibility of submitted papers

- [ ] The prestige of a well-known journal
- [ ] The option to make papers available publicly
- [ ] Lenient plagiarism checks
- [ ] Guaranteed citations

Video title: Open Access vs. Subscription Journals

14. Which of the following do/does NOT describe traditional journals?

- [ ] Articles are free of charge to view
- [ ] No permission is needed for reprints
- [ ] Strict copyright and licensing restrictions
- [ ] Rigorous peer review process
- [ ] Transfer of copyright from author to journal

Video title: Open Access vs. Subscription Journals

15. Which is/are NOT true of open access journals?

- [ ] They are fully available online
- [ ] They are free from copyright and license restrictions
- [ ] They require a subscription fee
- [ ] There has been little growth since their inception

Video title: Peer review

16. Which of the following are ADVANTAGES of a pre-submission enquiry?

- ☐ There is no need for the author to send a cover letter.
- ☐ The manuscript authors save time.
- ☐ The paper is accepted faster.
- ☐ The authors receive a rapid response.

Video title: Peer review

17. Which of the following are functions of the cover letter?

- ☐ It provides an argument for why a paper is appropriate for publication in the selected journal.
- ☐ It gives an overview of the purpose and findings of the paper
- ☐ It describes the authors' qualifications.
- ☐ It outlines the division of labor among the authors.

Video title: Peer review

18. Which of the following statements are INCORRECT with regard to selecting reviewers for your paper?

- ☐ You may recommend a reviewer if he/she is an expert on your topic.
- ☐ You should not request that certain reviewers be excluded from the peer review process.

- [ ] It is best not to exclude any reviewers from the peer editing process.

- [ ] You shouldn’t exclude more than 2-3 reviewers.

Video title: Peer review

19. Which of the following statements are CORRECT with regard to the peer review process? Select all that apply.

- [ ] The review process is democratic, and each reviewer has one vote.

- [ ] A paper can go through the peer review process multiple times.

- [ ] Each reviewer is responsible for giving feedback about the whole paper.

- [ ] Many experts are often invited to review a single paper.

Video title: Peer review

20. Which of the following statements are CORRECT regarding in-house editors and external editors? Select all that apply.

- [ ] In-house editors are practicing scientists and engineers.

- [ ] External editors work full-time for the journal.

- [ ] External editors are practicing scientists or engineers.

- [ ] In-house editors work full-time for the journal.

Video title: Reasons for Rejection

21. Which of the following is an ADVANTAGE of a journal transfer?

- [ ] It separates scientific soundness from interest level.
- [ ] It saves time for the reviewers.
- [ ] It saves time for the authors.
- [ ] It leads to a higher impact publication.

Video title: Reasons for Rejection

22. What are the frequent reasons for a paper to be rejected? Select all that apply

- [ ] Sample sizes are too small
- [ ] Methods used are of the state-of-the-art.
- [ ] Arguments/models are not supported by data.
- [ ] Conclusions are not strong.

Video title: Reasons for Rejection

23. Choose the CORRECT statement/s below.

- [ ] Plagiarism: The act of representing another's work as your own.
- [ ] Duplication and plagiarism are same.
- [ ] Duplication: publishing the same article twice.
- [ ] None of the options listed.

Video title: Reasons for Rejection

24. Which option/s below relate to the scientific soundness of a paper?

- [ ] Ethical concerns.
- [ ] Topic not within the journal's scope.
- [ ] Manuscript is suitable for a more specialized journal.
- [ ] Not a big enough advance.

Video title: Reasons for Rejection

25. If only old references are used in a paper (select all that apply)

- [ ] That may mean that interest has decreased or died on that topic.
- [ ] The writer may have omitted more up-to-date references.
- [ ] The paper will be rejected by the reviewers.
- [ ] This will mean that the reviewers will have to do more work.

Video title: How to Get Your Research Published

26. Which of the following should be avoided?

- [ ] Plagiarism
- [ ] Data Fabrication and falsification
- [ ] Use of improper author contribution

- [ ] Use of human and animal subjects

Video title: How to Get Your Research Published

27. When planning for the materials and methods, ethics approval _____.

- [ ] is not required for all experimentation
- [ ] is granted after successful publication
- [ ] is only required for human trials
- [ ] is only granted to a limited number of experiments per year
- [ ] is a necessary step for any experiments involving animal and human testing

Video title: How to Get Your Research Published

28. Valuable contributions can include.

- [ ] Negative results
- [ ] Proof of reproducibility
- [ ] Improved results using the exact same materials and methodology
- [ ] An improved method or technique
- [ ] Review or survey of previous literature

Video title: How to Get Your Research Published

29. Which of these questions need to be considered when writing the discussion/interpretation section of a research article?

- [ ] What do the results really show?
- [ ] How does this fit with existing knowledge?
- [ ] What are the limitations of the study?
- [ ] What is new about the findings?

Video title: How to Get Your Research Published

30. Ethics approval is most closely related to which section of your paper?

- [ ] Abstract
- [ ] Introduction
- [ ] Methodology
- [ ] Conclusion

Submit

Bottom of Form: Quiz 10

Chapter 10: Appendix Four

Semi-structured Interview Questions

Usefulness of group notes

1. Did you use the collaborative notes when taking quizzes?

2. Did you use the collaborative notes when completing writing assignments?

3. Did the collaborative notes help in your understanding of course concepts?

4. Did collaborative notes help you recall information from the lectures?

5. How did the notes your group produced compare to the notes you would have taken on your own?

6. Did you find other members editing of your writing helpful or harmful to the quality of the notes you produced?

7. Would you like to take collaborative notes again in a future course?

Equality of labor

8. How did collaborative note-taking compare to taking notes by yourself in terms of workload?

9. Did you take any private notes that you did not share with your group members?

10. Was work divided evenly among your group members? Were you satisfied with the process?

Video viewing habits

11. Did you watch all assigned course videos?

12. Did you ever skip watching assigned course video when other group members provided shared notes on that topic?

13. Did taking collaborative notes cause you to rewatch parts or all of any course videos?

14. Is there anything else you would like to comment on or add regarding collaborative note-taking or the course in general?

List of abbreviations

CFC Protocol	Courtney-Fanguy-Costley Protocol
CITI	Collaborative Institutional Training Initiative
COVID-19	Coronavirus Disease-19
CSCL	Computer Supported Collaborative Learning
Edu4.0	Education 4.0 initiative
ICC	Intraclass Correlation
IRB	Institutional Review Board
KAIST	Korea Advanced Institute of Science and Technology
MOOC	Massive Open Online Course
SCAPES	Studying Collaborative Authoring Practices in Educational Settings
STEM	Science, Technology, Engineering, and Mathematics
TA	Teaching Assistants
TEL	Technology-Enhanced Learning

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