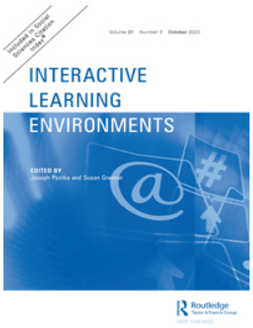

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How collaboration influences the effect of note-taking on writing performance and recall of contents

Mik Fanguy, Matthew Baldwin, Evgeniia Shmeleva, Kyungmee Lee & Jamie Costley

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How collaboration influences the effect of note-taking on writing performance and recall of contents

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ABSTRACT

Note-taking is a commonly applied pedagogical strategy across all areas of education. In higher education specifically, there has been an increasing push to get students involved in collaborative note-taking in order to increase their engagement with the contents and to inspire deeper and more meaningful learning. However, there is a lack of clarity as to whether collaborative note-taking positively influences student performance. For this reason, the present study (n = 189) compares the learning performances of students in a collaborative note-taking condition to those of students in an individual note-taking condition. The students were compared in regards to their retention of information and their performance on academic writing. The study found that students from the collaborative note-taking group performed better on measures of retention, while the individual note-taking group performed better on measures of academic writing. These results suggest that while the collaborative processes of group note-taking lead students to retain more information, these processes do not lead to better performance in academic writing. The present study fills a gap in the research by showing how the effectiveness of collaborative note-taking might depend on the learning context or on the desired result of the class.

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Introduction

As collaborative learning has been a prevalent pedagogical approach since the 1980s, the current generation of instructors may see collaboration as a positive pedagogical approach suitable for most, if not all, learning contexts (Menekse & Chi, 2019; O'Donnell, 2006). More specifically, collaboration is a commonly-used practice in higher education, where it has been integrated into curricula across disciplines within both online and traditional on-campus classrooms (Nokes-Malach et al., 2015). This is because much research into collaboration in higher learning environments suggests it is of benefit to learners (Johnson et al., 2014). However, in spite of its ubiquitous implementation and a body of extant literature in its favor, questions remain regarding the inconsistent effectiveness of collaboration on learning (Kester & Paas, 2005; Zambrano et al., 2019). For this reason, much research in the field of education is focused on investigating the differing topics, contexts, and educational modalities that might be more or less appropriate for collaboration (Retnowati et al., 2017).

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The act of individuals taking notes in lectures is a proven strategy that is deemed an essential approach to learning (van de Sande et al., 2017). This importance manifests itself in improved student learning and performance in class (Luo et al., 2018). Furthermore, engaging in note-taking correlates with achievement (Fisher & Harris, 1973; van de Sande et al., 2017) because of better retention and recall (Fisher & Harris, 1973; Rickards & Friedman, 1978), increased attention to material (Kane et al., 2017; Kiewra, 1987), and the memory benefits, i.e. storage and encoding, that come from recording the notes (Peverly & Wolf, 2019). For these reasons, note-taking is prevalent with students participating in offline and online classes (Liu et al., 2019; Veletsianos et al., 2015).

Some researchers have suggested that collaborative note-taking in particular might be more effective than taking notes individually (Harbin, 2020). This is because it may be the case that note-taking places a cognitive burden on learners, which might be better resolved when working in a group rather than individually (Chen et al., 2021). The cognitive challenge of trying to comprehend, process, and record information may be divided among group members, allowing students to retain more of the information from collaborative note-taking (Orndorff, 2015; Shi et al., 2020). If learners share the workload of note-taking among a group, individual members' cognitive capacities will be freed up, leading to higher levels of learning (Kirschner et al., 2018).

Because of the potential benefits of collaborative note-taking, some universities actively encourage instructors to promote collaborative note-taking (Laudari, 2019). Therefore, researchers have started to investigate how effective collaborative note-taking is and in what contexts it can be most readily applied (Veletsianos et al., 2016). Much of the research into the area of collaborative note-taking is based on perceived learning as self-reported by students and instructors, not grounded in class assessment or direct measures of performance. Regardless, such research has shaped the discussion on collaborative learning's efficacy and led to its widespread use. Consequently, more needs to be known about whether collaborative learning is suitable in the context of note-taking, and the present study seeks to develop a more nuanced empirical discussion of the topic.

Literature review

Student note-taking in the context of higher education is seen to be an effective strategy to improve student learning (Wu, 2020). Aside from the benefits of taking notes for oneself, there has been research that suggests sharing notes, and taking or reviewing notes in groups is also beneficial. Kiewra (1989) found that those who borrowed notes from attendees that did not attend the lecture themselves performed similarly on assessment measures to those who originally took and reviewed the notes. Luo et al. (2016) found that students who collaborated with a partner to revise their notes, recorded more original and complete information. In the case of an offline synchronous class, students who participated in a collaborative note-taking condition using shared Google Documents achieved on average a letter grade higher than their peers in the control group who took the same course (Orndorff, 2015). In an asynchronous online learning environment, Balwin et al. (2019) saw better learning outcomes for group note-takers than those in the control group, who were advised to take notes individually. However, a key limitation in both of the studies (Baldwin et al., 2019; Orndorff, 2015) is that the researchers only monitored and examined the collaborative note-taking documents. Consequently, it is unknown how much note-taking members of the control group actually did. In these cases, it is possible that the learning effects of collaborative note-taking were compared to the effects when no notes were taken at all.

In regards to the amount students write when they take notes and their learning performance, there is a large corpus of research literature showing a positive relationship between the quantity of words in students' written notes and their learning outcomes (Haynes et al., 2015; Kiewra, 1987). Mueller and Oppenheimer (2014) found that the number of words in students' notes was positively correlated with their ability to recall concepts from lectures they attended. Consequently, volume has been regarded in the literature as an important measure of the quality of the notes

students take. Research has shown that collaborative note-takers take a larger volume of notes than individual note-takers and tend to perform better on related exams (Kam et al., 2005), and it has been suggested that increased volume in collaborative notes may help students generate more ideas on the topics being focused on (Adeniran et al., 2019; Doberstein et al., 2019). However, more voluminous notes may not always be best, as Mueller and Oppenheimer (2014) also found that increased word counts correlated with reduced learning in cases where notes were written as word-for-word transcriptions of the lectures. In such cases, students may become overburdened with trying to copy down every word being spoken rather than thinking critically about the lecture concepts and encoding those ideas to their working memories.

Collaboration has been shown to have a variety of effects depending on learning contexts. Collaboration in small groups has enabled greater academic achievement (Menekse & Chi, 2019; O'Donnell, 2006) and better learning outcomes (Le et al., 2013). However, while reviewing group versus individual work in a classroom setting, evidence for collaborative learning's efficacy is mixed and provides some evidence that those in a group perform worse than they would have alone (Nokes-Malach et al., 2015; Retnowati et al., 2017). Included in that review is evidence of students' positive attitudes toward working in groups and the belief that their learning was of a higher standard than when they worked alone. Crucially though, the group members did not perform as well as those who studied individually (Leidner & Fuller, 1997). The outcome of the effect, therefore, does not always equate to what it is perceived to be.

Retention of learned information is an important aspect of education as a student needs to store course material in long-term memory in a manner that allows it to be called upon at a future time (Roediger & Karpicke, 2018). There is evidence that working together can aid retention of learning material (Johnson et al., 2014). Collaboration has been seen to help those within a group retain more class material when the individuals divide up a task and concentrate on different parts (Tindale & Winget, 2017), whereas a meta-analysis by Marion and Thorley (2016) found that working together in groups to memorize can help individuals recall information by themselves later. It is worth noting that according to the encoding hypothesis, which relates to note-taking directly, the act of note-taking in itself assists learning and the remembering of information. However, dividing the task of note-taking among members of a group may reduce this positive effect for each individual. This leads to two key questions: (1) How important is encoding? and (2) If during collaboration, encoding is diminished, can this be countered by a potentially improved product (storage) for the group members to review from?

Conversely, there are occasions when working together is detrimental to recall. The Retrieval Strategy Disruption Hypothesis (Basden et al., 1997), whereby the output of one group member impedes the retrieval processes of another, is an oft-given reason why collaborative inhibition occurs (Marion & Thorley, 2016). The group consequently retrieves less information than individuals, as collaboration may disrupt learners' ability to construct their own knowledge (Abel & Bäuml, 2017). Further disruption to retention has been noted in the form of cognitive transactional costs (Kirschner et al., 2009) - the mental time and effort spent assisting or listening to others in the group - expendable resources that might be better employed in learning the material by oneself.

Despite the cognitive transactional cost as well as retrieval strategy disruption, the act of working in groups has the potential to aid practice and performance of a task. Through the activity itself, participants in a group may recognize gaps in their own learning and seek guidance from their peers (Doo et al., 2020; Shin et al., 2020). Those more knowledgeable about a subject may give information or suggestions, such as ways to approach a goal or an explanation for information another student finds confusing. In these ways, collaboration facilitates scaffolding – that is, it enables group members to do that which they could not have done without the assistance of others (Vygotsky, 1978).

Transfer of learning, often seen as the goal of learning, is the application of knowledge one has acquired in the past, to a new, similar context (Pan & Rickard, 2018). A typical practice in higher education is for instructors to convey new theory or knowledge in the classroom and have students

practically apply it to a problem or scenario. In this regard, unstructured/structured small-group learning has been found to have a positive effect on students' later individual attempts at learning transfer (Pai et al., 2015). Doing group activities provides an opportunity to practice a skill; however, how the task is divided between members could restrict that opportunity. An instance where this can be crucial is second language learning (L2), and in particular when learning to write in an L2. The intricacies of academic writing dictate that a L2 learner needs to practice the different writing skills through individual experience (Myles, 2002). Observing someone else conducting a writing skill in a group is not the equivalent of performing it oneself, first hand. This lack of application could diminish the positive effect that practice alone has on accuracy in essay writing (Robb et al., 1986).

The present study

The present study seeks to measure and compare the learning effects of two approaches to note-taking in a course featuring online video instruction: (1) individual note-taking, wherein each student is responsible for recording his/her own set of notes, and (2) collaborative note-taking, wherein students are responsible for taking notes collaboratively in shared online documents in small groups. To do so, participants were divided into two groups, with one group taking notes individually and the other taking notes collaboratively in small groups. As prior experimental studies on collaborative note-taking (Baldwin et al., 2019; Orndorff, 2015) have not monitored the amount of notes that were taken in the control (non-collaborative) condition, in the present study, students' online note-taking documents from the individual and collaborative note-taking conditions were created and monitored by the course instructor. In this way, the amount of notes taken by students from each condition could be assessed. Learning outcomes were measured in two ways. Students' ability to recall contents from the online lecture videos were measured through their individual scores on online quizzes, as quizzes are widely acknowledged as a useful measure of learners' comprehension of learning content (Herold et al., 2012; Kamuche, 2011). Students' writing ability, which is the focus of the scientific writing course examined in this study, was assessed by evaluation of their individual writing assignments. This study seeks to answer the following research questions:

RQ1: Does collaborative note-taking increase students' recall of course concepts from lecture videos as compared to individual note-taking?

RQ2: Does collaborative note-taking increase students' writing ability as compared to individual note-taking?

RQ3: Do individual note-takers write more than collaborative note-takers?

The study has three main hypotheses:

H1: Students in the collaborative group will earn higher scores on related quizzes than students taking notes individually.

H2: Students in the collaborative group will earn higher scores on individual writing assignments than students in the individual note-taking condition.

H3: The volume of notes taken by individual note-takers will be higher than that of constituent members of collaborative note-taking groups.

Methodology

Participants and learning context

There were 186 students engaged in online note-taking in 10 different course sections of a graduate scientific writing course at a Korean university. All students who enrolled in the course were majoring in STEM (science, technology, engineering, and math) fields. There were 8–25 students in each

course section. Each of the 189 students joined sections (classes) that were designated as either individual or group note-taking. There were 6 sections designated as collaborative and 4 as individual note-taking. Within the group note-taking condition, there were 27 groups with 3, 4, or 5 members. 128 subjects were masters students, and 58 were in a doctoral program. There were 48 females and 138 males. The average age of the students was 25.5 (SD = 2.5), with a minimum value 22 and a maximum value 36.

The participants were divided into two groups, with one being a collaborative note-taking group (123 students) and the other being an individual note-taking group (63 students). Both groups had a similar composition of gender and age. The group participants did not differ significantly by gender ($X2(1) = .639$, $p = .424$), age ($t = -0.907$, $p = .365$), or educational level as approximated by the pre-test quizzes ($t = .998$, $p = .319$). The pre-test was a 10-item quiz given at the start of the semester. This pre-test consisted of items from each of the weekly topics that the course covered to see the students' level of knowledge of the information covered in the course.

In the scientific writing course that was the focus of this study, graduate students learn to write a manuscript on their research findings for publication in an academic journal (Fanguy et al., 2021). Course lectures were provided as online videos on the course learning management system in streaming format. The course comprises 10 instructional weeks, and each week includes 4–8 lecture videos, with a total of 56 videos for the course. The average duration of the videos was approximately 12 min, with the shortest video being 4:56 and the longest video lasting 24:50.

During each instructional week, learners were also requested to take notes on the video contents. Students in the individual note-taking group were asked to take notes individually, while students in the collaborative note-taking group were asked to do so in small groups of 3–5 students, which students were allowed to self-select into (with instructions to try to keep groups to 4 or 5 students). The notes that were taken by students in each treatment condition were taken using Google Documents that were created and monitored by the professor teaching the course. Therefore, in the individual note-taking group, each student in the course took notes in 10 individual Google Documents that corresponded to the 10 weeks of course instruction. Similarly, in collaborative note-taking groups, each group took notes in 10 shared Google Documents that corresponded to the 10 weeks of course instruction. As the course videos were provided on the course learning management system, students in both treatment groups could access the videos as often as they desired and could rewind, pause, or fast-forward while note-taking. At the end of each week of instruction, all learners were given an online quiz covering the learning content covered in the course videos of that week. The instructor of the course encouraged all students from both conditions to refer to the notes they had written on the online lecture videos when taking the related quiz. The quizzes covered a variety of topics discussed in the lecture videos including academic writing conventions, ethical issues related to the communication of scientific research, and navigation of the submission and peer review process of academic journals. Such topics were deemed by the course instructor to be appropriate to be assessed with quizzes. From the notes that students wrote in each of the two treatment conditions, data was mined for the volume of words written.

Measures

Volume. The number of words contributed by each student to the final version of each of 10 note-taking documents during the semester was tallied, and this sum served as the volume variable in this study. In the individual note-taking group, the total number of words written in all note-taking documents was used as the volume variable. In the collaborative note-taking group, the total number of words contributed to all of the collaborative note-taking documents by each constituent group member served as the volume variable. In order to operationalize the volume variable, the total word count of each document was assessed using a program written in Python language (https://github.com/porkchop-jim/Collab_Notetaking)

Quiz scores. A total of 10 quizzes were given online during the semester in order to measure students' recall and understanding the content from video lectures during each of the 10 instructional weeks. Each quiz consisted of 8–30 multiple-choice items based on the concepts of the online videos from the corresponding instructional week. Students were given only one attempt to take each quiz, and quiz attempts were timed with two minutes allowed for each question. Students were required to take each quiz by 6 pm on the Friday of each instructional week. The quiz items were designed to allow for more than one answer choice to be selected, and students were awarded partial credit when fewer than the total number of correct options were selected. However, if an incorrect answer option was selected, a score of 0 was given for the quiz item in order to discourage students from indiscriminately guessing when they did not understand the learning content being measured. The scores of each quiz were weighted equally in order to account for 3% of the course grade point total. Therefore, the total 10 quiz scores, each of which was worth 3% of the grade total, were combined to account for 30% of the grade point total for the course. The Cronbach's (1951) alpha coefficient for the student's total quiz scores was .897 from 151 total items. These results indicate that the quizzes provided a moderately reliable measure of the learning content of each instructional week. More information about each quiz item and its relationship to the instruction can be viewed at the following URL under the label of "quiz items and video list": https://osf.io/5t8vw/?view_only=3514f73b64b1497a9948e1a544d565bc.

Individual writing assignments

The scientific writing course examined in the present study required students to submit five individual writing assignments corresponding to six major sections of a research article: Introduction, Methodology, Results, Discussion & Conclusion, Abstract, and References. Each of these assignments were evaluated using rubrics (Appendix A) that were adapted from those proposed by Clabough and Clabough (2016) and were scored by the course instructor on a scale of 0-10, with each assignment accounting for 10% and all six assignments accounting for 60% of the course grade point total. The summed scores of these six assignments were used as the individual writing variable in the present study. To ensure reliability of rating, two instructors of the scientific writing course separately rated 10 randomly selected writing samples as part of a norming session and discussed instances where differences in scoring occurred. After acceptable scoring calibration was achieved, the two instructors simultaneously scored 20% of all writing samples submitted from all 6 sections of the course being examined.

Survey. Furthermore, the students took a survey at the completion of the course. The survey was administered to both treatment groups in the present study. Survey items covered various topics including, student demographics, the usefulness of notes, the effectiveness of the Google Documents platform, and video viewing practices and habits. Two survey items of interest to the present study were analyzed to see how they differed between the individual and group note-taking condition: *I always watched all the course videos*, and *Taking notes made me more likely to rewatch parts or all of a given course video.* These were Likert-like items from 1 - 7 which asked students to respond to either "very true of me" which was a 7, to "not at all true of me," which was a 1. These items both represent the way students interact with the materials in the course in relation to their note-taking and therefore will help add to our understanding of the differing note-taking behaviors of the participants in the individual and collaborative note-taking conditions.

Results

Before comparing the treatment groups by learning outcomes, we used the Shapiro–Wilk test to test the assumption of normality of data distribution and Levene's test to test the assumption of equal variances (homoscedasticity). The results indicated that both assumptions hold for weekly quizzes scores ($F = .31$, $p = .579$ for Levene's test, and $W = 0.99$, $p = .304$ for the Shapiro–Wilk test), but do

not hold for individual writing assignments (F = 4.85, $p = .028$ and W = 0.95, $p < .000$, respectively). Therefore, we used a parametric t-test to check the significance of the differences in quizzes scores and a nonparametric Mann–Whitney *U* test to check the significance of the differences in individual assignment scores.

The results show (Tables 1–2) that the collaborative note-taking group had a 1.38 higher average weekly quiz scores than the individual note-taking group (hypothesis 1 is held), and this difference was statistically significant (t = −3.67; $p < .000$). A comparison of the individual written assessment scores reveals that the collaborative note-taking group had a 3.08 lower writing scores than the individual note-taking group, and this difference was statistically significant (z = 5.25; $p < .000$). This provides evidence for the rejection of hypothesis 2.

We use the information about how students interacted with the materials to explain the differences in learning outcomes in the individual and group note-taking conditions – (1) volume of notes, (2) watching all the videos during the course, and (3) rewatching parts of the videos during the course. All the variables fail the Shapiro–Wilk test for normality (W = .83, $p = .000$ for the first variable, W = 0.81, $p = .000$ for the second one, and W = .93, $p = .000$ for the third one). Only the variable indicating watching all the videos during the course passes the test for homoscedasticity (F = 2.76, $p = 0.097$). The assumptions for homoscedasticity for the first and the third variables do not hold (F = 55.70, $p = .000$ and F = 7.50, $p = .006$, respectively). Therefore, we use a nonparametric Mann–Whitney *U* test to check the significance of the differences in individual assignment scores.

As detailed in Table 3, the individual note-taking group had a 3582.97 significantly higher volume of notes (z = 7.82; $p < .000$; hypothesis 3 is held), a .34 higher score on the variable indicating watching all the course videos (z = 2.11; $p = .034$), and a .67 higher score on the variable indicating rewatching the videos (z = 2.41; $p = .015$) than the individual note-taking group. These results suggest students from individual note-taking groups interacted with the course materials more than students from the other treatment group.

Discussion

The students who were in the collaborative condition in the present study performed better on the weekly quizzes than those in the individual condition. These quizzes provided a measure of the student's retention of materials from the course's online video lectures (Roediger & Karpicke, 2018). The present study falls in line with other research that suggests that collaboration benefits students learning generally (Johnson et al., 2014), as well as retention of information specifically (Marion & Thorley, 2016). On the other hand, previous studies have suggested that collaboration may interrupt a learner's ability to retain and recall information and may also introduce a cognitive transaction cost to completing the task as a group (Marsh & Rajaram, 2019), as learners must spend time and mental effort in order to share information with one another. Moreover, when an individual group member contributes dominantly to a learning task, other members may not get ample opportunities to engage, which may hinder their learning (Hew & Brush, 2007). This may also have occurred in the present study, as the amount of notes contributed was not always evenly balanced among group members in the collaborative note-taking condition. However, while there may be some collaborative inhibition, transaction costs, and unequal participation from the learner-to-learner interaction, the present findings suggest that the benefits of reducing students' cognitive burden as well as

Table 1. The gender, age, and pre-tests results of the participants, $N = 186$

	Gender	Frequency	Percent	Age (Mean / SD)	Pre-test quiz results (Mean / SD)
Individual note-taking group (N=63)	Female	14	22.22	25.14 / 2.79	5.15 / 1.20
	Male	49	77.78	25.36 / 2.37	5.23 / 1.27
Collaborative note-taking group (N=123)	Female	34	27.64	25.11 / 1.90	5.36 / 1.38
	Male	89	72.36	25.88 / 2.78	4.87 / 1.62

Table 2. Student outcomes, t-test, and Mann-Whitney U test for the individual note-taking group and the collaborative note-taking group

	Weekly quiz scores	Individual writing assignment scores
Individual note-taking group (N=63)		
Mean	20.51	44.63
SD	2.44	3.16
Collaborative note-taking group (N=123)		
Mean	21.89	41.55
SD	2.42	4.12
Test for differences		
Mean difference	−1.38	3.08
t value[a]	−3.67	
z value[b]		5.25
p value	0.00	0.00
Total (N=186)		
Mean	21.43	42.59
SD	2.51	4.08

Notes: a – t-test; *b* – Mann-Whitney *U* test

Table 3. The means of the parameters of the course participation and Mann-Whitney U test for the individual note-taking group and the collaborative note-taking group

	Volume of notes	Watching all the course videos	Rewatching parts or all of a given course video.
Individual note-taking group (N=63)			
Mean	6269.41	6.49	5.61
SD	3321.39	0.89	1.18
Collaborative note-taking group (N=123)			
Mean	2686.43	6.15	4.94
SD	1417.20	1.18	1.72
Test for differences			
Mean difference	3582.97	0.34	0.67
z value	7.82	2.11	2.41
p value	0.000	0.034	0.015
Total (N=186)			
Mean	3900.02	6.26	5.17
SD	2812.93	1.10	1.59

the increased amount of focus collaboration brings outweigh the aforementioned disadvantages of collaboration.

The students who took notes individually outperformed the students who took collaborative notes in regards to their performance on academic writing. These pieces of writing were the main focus of the course and involved students completing an individual paper related to their own area of research interest. The present study's results do not support research that shows that collaboration can help students notice gaps in their knowledge and allows scaffolding and feedback from other learners (Doo et al., 2020). However, the present study's results do correspond to those of Leidner and Fuller (1997), who found that although students who worked in collaborative groups expressed more interest in the learning content and perceived learning, while students who worked individually exhibited better learning performance. Leidner and Fuller explained this result by surmising that learning activities done by oneself allow the learner to process information in a way that allows them to understand the information more deeply and apply skills from that processing at a later time. Similarly, students in the individual note-taking condition of the present study may have benefited from processing information on their own rather than in groups.

Several other variables were considered after the main hypotheses were investigated. The volume of the individual note-taking and collaborative note-taking conditions were compared, and this showed that individual note-takers took more than twice the amount of notes (in terms of word

count) than collaborative note-takers. This finding seems intuitive as the collaborative note-takers are sharing the amount of notes required for each class, leading them to write less individually. This is of pedagogical importance because, if students practice a skill less, they will not perform as well as those who have practiced the skill more (Robb et al., 1986). The present study supports this and suggests that even though collaboration is often used as an instructional activity to encourage students' practice, it may in fact lead to less individual practice of the skill being applied. This is particularly salient in the case where the skill being practiced either in a group or individually is close in kind to the outcome variable of interest. In the case of the present study, academic writing and note-taking are similar in that they are both writing. It has been demonstrated that when learners are trying to improve their second language, practice is of great importance (Nalliveettil & Mahasneh, 2017). This suggests that the better results in regards to writing found for the individual note-takers may be caused by those learners having more practice of the skills that the class is focused on as compared to the collaborative note-takers.

Also, to further understand the differences found in the main variables of interest, two survey items of interest were assessed. The students were asked "how true it was of them" that they "always watched all the course videos." In this regard, students in the individual note-taking condition had higher average scores, meaning that they were more likely to watch all the videos. Furthermore, the students were asked "how true it was of them" that "Taking notes made me more likely to rewatch parts or all of a given course video." In this case, the individual note-takers also scored higher on average than the collaborative note-takers. There are two possible explanations for this: (1) that students who took individual notes were more focused because they were responsible for taking notes for all the course videos without help from others, or (2) students in the collaborative condition felt that they did not need to watch all the videos as they had access to peer-created notes. This shows that what is seen as an advantage in collaborative learning (distribution of workload) may cause potential issues as it may lead to students being less engaged with the course materials.

It should be noted that the issues with collaboration discovered in this study's results are a little different from the "free-rider effect" noted in the literature (Strijbos & De Laat, 2010). In the free-rider effect, students rely on others within a group to help complete a group activity. This may or may not have occurred in the present study; however, it may be the case that regardless of students' performance in collaborative activities, students will interact less with the course materials because the nature of collaboration leads to fewer requirements for them to engage with the contents. So while prior work on the free-rider effect describes it as an individual member gaining benefits from group labor with minimal contribution (Strijbos & De Laat, 2010), the present study suggests that such an approach may come at the expense of the individual's own learning outcomes. While prior studies on free-riding have tended to focus on self-reported perceived levels of learning and satisfaction with collaboration among group members, the present study has measured the individual learning performances of the members, providing useful insights into the effects of free-riding. This shows how the present study distinguishes itself from previous research and gives a more focused, in-depth understanding of collaboration's effect on student performance.

Pedagogical recommendations

This study finds that more nuance is required when applying collaborative learning in an online setting. Generally speaking, there is a tendency to consider that more collaboration is always better (Menekse & Chi, 2019; O'Donnell, 2006). However, the present study finds this is not the case. As can be seen from the results, while collaboration was beneficial for the students' retention of information, it was better for the student's academic writing to write notes individually. The overarching pedagogical recommendation that can be drawn from this is that context and objectives play a large part in determining if collaborative learning should be implemented. Therefore, there

are four more specific pedagogical recommendations: (1) When retention is important, collaborative note-taking is effective; (2) academic writing will show greater improvement if students work individually on note-taking; (3) more writing practice will help with student writing performance; and (4) group activities should be systematically designed to promote effective collaboration.

The first recommendation is that collaboration has great benefit in instances where the goal of instruction is to help students better understand and recall concepts and information. Collaborative activities where group members attempt to collectively record and build knowledge will help to deepen their understanding of course concepts and improve retention. This occurs because students can share the burden of recording information, which can free cognitive resources to make deeper connections with the content (Costley & Fanguy, 2021). Collaborative note-taking from this perspective is situational. When the course goals are focused around building knowledge as opposed to practicing a particular skill then collaborative note-taking can be a good pedagogical practice.

The second recommendation is that academic writing is a skill that requires practice from students in order to improve and gain mastery (Johari, 2018; Myles, 2002; Nalliveettil & Mahasneh, 2017; Silliman et al., 2020). Therefore, academic writing courses should include substantial writing assignments that require students to invest time and effort engaging in the writing process. The third and perhaps more surprising recommendation of the present study is that such assignments should be completed individually rather than in collaborative groups because students will gain more practice when the practice afforded by the task is not shared among several members, but is instead assigned to a single learner.

The fourth recommendation of the present study is that when instructors include collaborative learning activities into their courses, care must be taken to ensure that the proper conditions exist for meaningful collaboration to occur (Ellis & Han, 2020). For example, a prior study found that members of a group that collaborated through a shared online instructional interface exhibited higher levels of recall on a test than students in the control condition who studied offline in a non-collaborative manner (Szewkis et al., 2011). The authors noted that for successful collaborative learning to occur, there are a number of necessary conditions: sharing a common goal, positive interdependence among members, coordination and communication, individual accountability, awareness of peers' work, and joint rewards. The fact that the online collaborative note-taking condition in the present study contained all of these conditions may help to explain the similarity of the present findings to those of Szewkis et al. Because students were able to use the notes they created in their groups in order to study for the weekly quizzes, they had a clear common goal, which also helped to create a sense of interdependence or reliance on one another. Groups had to decide amongst themselves how to divide the work and create the notes, but individuals could be held accountable for their contribution since each group member, as well as the course instructor, could clearly see who wrote each part of the notes. Therefore, members were aware of the contributions or lack thereof of each member. Lastly, student groups who took high-quality notes shared in the joint reward or benefit of having a highly complete set of notes with which to study for quizzes.

Aside from the specific case of note-taking and academic writing, the study results also emphasize a more generalizable concept at play in collaborative learning situations. In many cases, collaboration may lead to students engaging in less practice of a skill than they would if they were to apply the skill on their own. While the underlying processes of collaborative learning might lead them to enjoy the processes more and perhaps to retain the information better if they collaborate, they will not have the ability to actively engage in the skill they are trying to develop. A simple analogy may help to illustrate. Imagine students are learning how to do Cardiopulmonary Resuscitation (CPR) on a practice dummy. In one case, there is a group of four learning this skill while sharing one dummy, and in another case, an individual is practicing alone on one dummy. The group may enjoy the process of learning how to do CPR due to interactions with their partners, and the processes of collaboration may lead them to remember the steps of procedure better than the

individual. However, the individual has four times the amount of time on task to practice on the dummy. This analogy may help to demonstrate what is happening in the present study and in other cases of collaboration: collaborative groups may have better understood and remembered many of the concepts from the course due to their interactions with one another, but individual note-takers did five times as much writing to complete their notes and therefore gained valuable writing practice. For this reason, careful consideration must be given to the type of contents that the students are learning and whether the relative value of collaboration is outweighed by the lessening amount of practice the students will engage in.

Conclusion

This study compared the students' performances in online classes in both weekly quizzes and academic writing. The students were divided into a condition where they took notes individually, or in collaborative groups. The results show that students in the collaborative condition performed better on the quizzes, while the students in the individual note-taking condition performed better on the writing tasks. This study provides new insights into how note-taking affects student performance from a collaborative perspective. Previous studies have tended to look at either collaborative note-taking or individual note-taking by themselves, and have not compared them as our study has done.

The present study also brings a more balanced narrative into the recent conversations on the effectiveness of collaborative learning activities for individual student learning performance. Advanced communication technologies have enabled researchers and educators to realize the social constructivist ideal of student learning as a collaborative knowledge construction process in different pedagogical settings. A growing volume of literature has documented the positive sides of computer-supported collaborative learning and associated challenges to implementing those activities in classrooms. As the scholarship has been established and mature, we argue it has reached its tipping point where more research efforts need to be exerted to develop a comprehensive account of the effects of collaborative learning activities across different subject matters and intended learning outcomes. Learning is multi-focal endeavors, strongly influenced by the nature of a focused set of knowledge and skills. When it comes to the question of effective pedagogical approaches, therefore, the answers vary across disciplines and different stages of learner development. In that regard, this particular study contributes to adding nuance to the literature by showing that while collaboration may be an effective tool at improving the retention of lecture contents, it reduces the amount of academic writing practice a student might engage in. That is, those in the individual note-taking condition wrote twice as much as those in the collaborative condition.

Despite these contributions, the present study has a number of limitations that must be addressed. The first is that the only aspect of the notes that was assessed was volume. However, the quality of the notes, for example how many of the main concepts from the lectures are written down, is another important aspect of note-taking quality that was not assessed. It is possible that the improved retention of course concepts by the collaborative note-takers could have been due to creating and having access to higher quality notes than those of individual note-takers; however, as this study did not measure quality, such a relationship cannot be examined. Therefore, future research should evaluate and compare the quality of notes taken between individual and collaborative note-takers. A second limitation is that this study used self-reported information from survey items in order to assess students' video viewing habits, and clickstream behavior would have been a more effective method of doing so. As clickstream data was unavailable from the university learning management system, future research should examine the relationship between collaborative note-taking and the tendency to view videos. Considering the ubiquitousness of note-taking and benefits to be gained from collaboration, this is an area that is rich for further potential investigation.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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References

Abel, M., & Bäuml, K. H. T. (2017). Collaborative remembering revisited: Study context access modulates collaborative inhibition and later benefits for individual memory. *Memory & Cognition*, *45*(8), 1319–1334. https://doi.org/10.3758/s13421-017-0737-9

Adeniran, A., Masthoff, J., & Beacham, N. (2019). Model-based characterization of text discourse content to evaluate online group collaboration. In S. Isotani, E. Millán, A. Ogan, P. Hastings, B. McLaren, & R. Luckin (Eds.), *Artificial intelligence in education*. AIED 2019. Lecture Notes in Computer Science, Vol. 11626. Springer, Cham. https://doi.org/10.1007/978-3-030-23207-8_1

Basden, B. H., Basden, D. R., Bryner, S., & Thomas, R. L. III. (1997). A comparison of group and individual remembering: Does collaboration disrupt retrieval strategies? *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *23*(5), 1176–1189. https://doi.org/10.1037/0278-7393.23.5.1176

Baldwin, M. P., Fanguy, M., & Costley, J. H. (2019). The effects of collaborative note-taking in flipped learning contexts. *Journal of Language & Education Volume*, 5(4). https://doi.org/10.17323/jle.2019.9726

Chen, S., Wang, D., & Huang, Y. (2021, May 8–13). *Exploring the complementary features of audio and text notes for video-based learning in mobile settings*. Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing systems. (pp. 1–7). https://doi.org/10.1145/3411763.3451801

Clabough, E. B., & Clabough, S. W. (2016). Using rubrics as a scientific writing instructional method in early stage undergraduate neuroscience study. *Journal of Undergraduate Neuroscience Education : JUNE : A Publication of FUN, Faculty for Undergraduate Neuroscience*, *15*(1), A85–A93. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5105970/

Costley, J., & Fanguy, M. (2021). Collaborative note-taking affects cognitive load: the interplay of completeness and interaction. *Educational Technology Research and Development*, *69*(2), 655–671. https://doi.org/10.1007/s11423-021-09979-2

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, *16*(3), 297–334. https://doi.org/10.1007/BF02310555

Doberstein, D., Hecking, T., & Hoppe, H. U. (2019). *What can interaction sequences tell us about collaboration quality in small learning groups?* In M. Herzog, Z. Kubincová, P. Han, & M. Temperini (Eds.), *Advances in web-based learning – ICWL 2019*. ICWL 2019. Lecture Notes in Computer Science, Vol. 11841. Springer, Cham. https://doi.org/10.1007/978-3-030-35758-0_6

Doo, M. Y., Bonk, C., & Heo, H. (2020). A meta-analysis of scaffolding effects in online learning in higher education. *International Review of Research in Open and Distributed Learning*, *21*(3), 60–80. http://www.irrodl.org/index.php/irrodl/article/view/4638

Ellis, R., & Han, F. (2020). Assessing university student collaboration in new ways. *Assessment & Evaluation in Higher Education*, 1–16. https://doi.org/10.1080/02602938.2020.1788504

Fanguy, M., Lee, S. Y., & Churchill, D. G. (2021). Adapting educational experiences for the chemists of tomorrow. *Nature Reviews Chemistry*, *5*(3), 141–142.

Fisher, J. L., & Harris, M. B. (1973). Effect of note taking and review on recall. *Journal of Educational Psychology*, 65(3), 321–325. https://doi.org/10.1037/h0035640

Harbin, M. B. (2020). Collaborative note-taking: A tool for creating a more inclusive college classroom. *College Teaching*, 1–7. https://doi.org/10.1080/87567555.2020.1786664

Haynes, J. M., McCarley, N. G., & Williams, J. L. (2015). An analysis of notes taken during and after a lecture presentation. *North American Journal of Psychology*, *17*(1), 175–186. https://www.researchgate.net/profile/Joshua_Williams4/publication/272417797_An_Analysis_of_Notes_Taken_During_and_After_a_Lecture_Presentation/links/54e3a2000cf2dbf60693a790.pdf

Herold, M. J., Lynch, T. D., Ramnath, R., & Ramanathan, J. (2012, October). Student and instructor experiences in the inverted classroom. 2012 *Frontiers in Education Conference Proceedings*. 1–6. IEEE. https://doi.org/10.1109/FIE.2012.6462428

Hew, K. F., & Brush, T. (2007). Integrating technology into K-12 teaching and learning: Current knowledge gaps and recommendations for future research. *Educational Technology Research and Development*, *55*(3), 223–252. https://doi.org/10.1007/s11423-006-9022-5

Johari, S. K. (2018). The effects of task-based process writing approach on the academic writing skills among second language tertiary learners. *Journal of ELT Research: The Academic Journal of Studies in English Language Teaching and Learning*, 1–20. https://doi.org/10.22236/JER_Vol3Issue1pp1-20

Johnson, D. W., Johnson, R. T., & Smith, K. A. (2014). Cooperative learning: Improving university instruction by basing practice on validated theory. *Journal on Excellence in University Teaching*, *25*(4), 1–26. Retried from http://personal.cege.umn.edu/~smith/docs/Johnson-Johnson-Smith-Cooperative_Learning-JECT-Small_Group_Learning-draft.pdf

Kam, M., Wang, J., Iles, A., Tse, E., Chiu, J., Glaser, D., … Canny, J. (2005, April 2–7). *Livenotes: A system for cooperative and augmented note-taking in lectures*. Proceedings of the SIGCHI Conference on Human Factors in Computing systems. (pp. 531–540). https://doi.org/10.1145/1054972.1055046

Kamuche, F. U. (2011). The effects of unannounced quizzes on student performance: Further evidence. *College Teaching Methods & Styles Journal (CTMS)*, *3*(2), 21–26. https://doi.org/10.19030/ctms.v3i2.5277

Kane, M. J., Smeekens, B. A., von Bastian, C. C., Lurquin, J. H., Carruth, N. P., & Miyake, A. (2017). A combined experimental and individual-differences investigation into mind wandering during a video lecture. *Journal of Experimental Psychology: General*, *146*(11), 1649–1674. https://psycnet.apa.org/doi/10.1037/xge0000362 https://doi.org/10.1037/xge0000362

Kester, L., & Paas, F. (2005). Instructional interventions to enhance collaboration in powerful learning environments. *Computers in Human Behavior*, *21*(4), 689–696. https://doi.org/10.1016/j.chb.2004.11.008

Kiewra, K. A. (1987). Notetaking and review: The research and its implications. *Instructional Science*, *16*(3), 233–249. https://link.springer.com/content/pdf/10.1007/BF00120252.pdf https://doi.org/10.1007/BF00120252

Kiewra, K. A. (1989). A review of note-taking: The encoding-storage paradigm and beyond. *Educational Psychology Review*, *1*(2), 147–172. https://link.springer.com/content/pdf/10.1007/BF01326640.pdf https://doi.org/10.1007/BF01326640

Kirschner, F., Paas, F., & Kirschner, P. A. (2009). A cognitive load approach to collaborative learning: United brains for complex tasks. *Educational Psychology Review*, *21*(1), 31–42. https://doi.org/10.1007/s10648-008-9095-2

Kirschner, P. A., Sweller, J., Kirschner, F., & Zambrano, J. (2018). From cognitive load theory to collaborative cognitive load theory. *International Journal of Computer-Supported Collaborative Learning*, *13*(2), 213–233. https://doi.org/10.1007/s11412-018-9277-y

Laudari, S. (2019). "Collaborative note-taking" in adaptable resources for teaching with technology. LX.Lab, Institute for Interactive Media & Learning, University of Technology, Sydney. https://lx.uts.edu.au/collections/adaptable-resources/resources/collaborative-note-taking/

Le, N. T., Loll, F., & Pinkwart, N. (2013). Operationalizing the continuum between well-defined and ill-defined problems for educational technology. *IEEE Transactions on Learning Technologies*, *6*(3), 258–270. https://doi.org/10.1109/TLT.2013.16

Leidner, D. E., & Fuller, M. (1997). Improving student learning of conceptual information: GSS supported collaborative learning vs. individual constructive learning. *Decision Support Systems*, 20(2), 149–163. https://doi.org/10.1016/S0167-9236(97)00004-3

Liu, C., Yang, C. L., Williams, J. J., & Wang, H. C. (2019, May 4–9). *Notestruct: Scaffolding note-taking while learning from online videos*. In *Extended Abstracts of the 2019 CHI Conference on Human Factors in Computing systems*. (pp. 1–6). https://doi.org/10.1145/3290607.3312878

Luo, L., Kiewra, K. A., Flanigan, A. E., & Peteranetz, M. S. (2018). Laptop versus longhand note taking: Effects on lecture notes and achievement. *Instructional Science*, *46*(6), 947–971. https://doi.org/10.1007/s11251-018-9458-0

Luo, L., Kiewra, K. A., & Samuelson, L. (2016). Revising lecture notes: How revision, pauses, and partners affect note taking and achievement. *Instructional Science*, *44*(1), 45–67. https://doi.org/10.1007/s11251-016-9370-4

Marion, S. B., & Thorley, C. (2016). A meta-analytic review of collaborative inhibition and postcollaborative memory: Testing the predictions of the retrieval strategy disruption hypothesis. *Psychological Bulletin*, *142*(11), 1141–1164. https://doi.org/10.1037/bul0000071 https://pubmed.ncbi.nlm.nih.gov/27618544/ https://doi.org/10.1037/bul0000071

Marsh, E. J., & Rajaram, S. (2019). The digital expansion of the mind: Implications of internet usage for memory and cognition. *Journal of Applied Research in Memory and Cognition*, *8*(1), 1–14. https://doi.org/10.1016/j.jarmac.2018.11.001

Menekse, M., & Chi, M. T. (2019). The role of collaborative interactions versus individual construction on students' learning of engineering concepts. *European Journal of Engineering Education*, *44*(5), 702–725. https://doi.org/10.1080/03043797.2018.1538324

Mueller, P. A., & Oppenheimer, D. M. (2014). The pen is mightier than the keyboard: Advantages of longhand over laptop note taking. *Psychological Science*, *25*(6), 1159–1168. https://doi.org/10.1177/0956797614524581

Myles, J. (2002). Second language writing and research: The writing process and error analysis in student texts. *Tesl-Ej*, *6*(2), 1–20. http://www. tesl.ej.org/wordpress/issues/volume6/ej22al/

Nalliveettil, G. M., & Mahasneh, A. (2017). Developing competence in basic writing skills: Perceptions of EFL undergraduates. *International Journal of Applied Linguistics and English Literature*, *6*(7), 323–341. https://doi.org/10.7575/aiac.ijalel.v.6n.7p.332

Nokes-Malach, T. J., Richey, J. E., & Gadgil, S. (2015). When is it better to learn together? Insights from research on collaborative learning. *Educational Psychology Review*, *27*(4), 645–656. https://doi.org/10.1007/s10648-015-9312-8

O'Donnell, A. M. (2006). The role of peers and group learning. In P. A. Alexander, & P. H. Winne (Eds.), *Handbook of educational psychology* (pp. 781–802). Lawrence Erlbaum Associates Publishers.

Orndorff IIIH. N. (2015). Collaborative note-taking: The impact of cloud computing on classroom performance. *International Journal of Teaching and Learning in Higher Education*, *27*(3), 340–351. https://files.eric.ed.gov/fulltext/EJ1093744.pdf

Pai, H. H., Sears, D. A., & Maeda, Y. (2015). Effects of small-group learning on transfer: A meta-analysis. *Educational Psychology Review*, *27*(1), 79–102. https://doi.org/10.1007/s10648-014-9260-8

Pan, S. C., & Rickard, T. C. (2018). Transfer of test-enhanced learning: Meta-analytic review and synthesis. *Psychological Bulletin*, 144(7), 710–756. https://doi.org/10.1037/bul0000151

Peverly, S. T., & Wolf, A. D. (2019). Note-taking. In J. Dunlosky, & K. A. Rawson (Eds.), *The Cambridge handbook of cognition and education* (pp. 320–355). Cambridge University Press. https://doi.org/10.1017/9781108235631.014

Retnowati, E., Ayres, P., & Sweller, J. (2017). Can collaborative learning improve the effectiveness of worked examples in learning mathematics? *Journal of Educational Psychology*, *109*(5), 666–679. https://doi.org/10.1037/edu0000167

Rickards, J. P., & Friedman, F. (1978). The encoding versus the external storage hypothesis in note taking. *Contemporary Educational Psychology*, *3*(2), 136–143. https://doi.org/10.1016/0361-476X(78)90020-6

Robb, T., Ross, S., & Shortreed, I. (1986). Salience of feedback on error and its effect on EFL writing quality. *TESOL Quarterly*, *20*(1), 83–96. https://doi.org/10.2307/3586390

Roediger IIIH. L., & Karpicke, J. D. (2018). Reflections on the resurgence of interest in the testing effect. *Perspectives on Psychological Science*, *13*(2), 236–241. https://doi.org/10.1177/1745691617718873

Shi Y., Yang H., Yang Z., Liu W., & Yang H. H. (2020). The effects of a collaborative learning approach with digital note-taking on college students' learning achievement and cognitive Load. In S. Cheung, R. Li, K. Phusavat, N. Paoprasert, & L. Kwok (Eds), *Blended learning. Education in a smart learning environment*. ICBL 2020. Lecture Notes in Computer Science, Vol. 12218. Springer, Cham. https://doi.org/10.1007/978-3-030-51968-1_16

Shin, S., Brush, T. A., & Glazewski, K. D. (2020). Examining the hard, peer, and teacher scaffolding framework in inquiry-based technology-enhanced learning environments: Impact on academic achievement and group performance. *Educational Technology Research and Development*, 1–25. https://doi.org/10.1007/s11423-020-09763-8

Silliman, E. R., Bahr, R. H., & Wilkinson, L. C. (2020). Writing across the academic languages: Introduction. *Reading and Writing*, *33*(1), 1–11. https://doi.org/10.1007/s11145-019-09993-0

Strijbos, J. W., & De Laat, M. F. (2010). Developing the role concept for computer-supported collaborative learning: An explorative synthesis. *Computers in Human Behavior*, *26*(4), 495–505. https://doi.org/10.1016/j.chb.2009.08.014

Szewkis, E., Nussbaum, M., Rosen, T., Abalos, J., Denardin, F., Caballero, D., … Alcoholado, C. (2011). Collaboration within large groups in the classroom. *International Journal of Computer-Supported Collaborative Learning*, *6*(4), 561–575. https://doi.org/10.1007/s11412-011-9123-y

Tindale, R. S., & Winget, J. R. (2017). Learning While Deciding in Groups. *The Oxford handbook of group and organizational learning*. https://psyarxiv.com/8ufgh/download?format=pdf

van de Sande, C., Abramson, J., & Judson-Garcia, J. (2017). An exploration of note-taking in an online calculus course. *Journal of Computers in Mathematics and Science Teaching*, *36*(1), 75–99. https://www.learntechlib.org/primary/p/174372/

Veletsianos, G., Collier, A., & Schneider, E. (2015). Digging deeper into learners' experiences in MOOC s: Participation in social networks outside of MOOC s, notetaking and contexts surrounding content consumption. *British Journal of Educational Technology*, *46*(3), 570–587. https://doi.org/10.1111/bjet.12297

Veletsianos, G., Reich, J., & Pasquini, L. A. (2016). The life between big data log events: Learners' strategies to overcome challenges in MOOCs. *AERA Open*, *2*(3), 2332858416657002. https://doi.org/10.1177/2332858416657002

Vygotsky, L. S. (1978). Socio-cultural theory. *Mind in Society*, 52–58.

Wu, J. Y. (2020). The predictive validities of individual working-memory capacity profiles and note-taking strategies on online search performance. *Journal of Computer Assisted Learning*, *36*(6), 876–889. https://doi.org/10.1111/jcal.12441

Zambrano, J., Kirschner, F., Sweller, J., & Kirschner, P. A. (2019). Effects of group experience and information distribution on collaborative learning. *Instructional Science*, *47*(5), 531–550. https://doi.org/10.1007/s11251-019-09495-0