Beyond traditional note-taking: Comparing the effects of collaboratively-generated versus instructor-provided notes on recall and writing performance

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Note-taking is generally regarded as an effective learning strategy, but it is also cognitively demanding. Students often omit salient information in their notes due to the burden of trying to listen while writing down what they hear. Two alternative forms to traditional note-taking are online collaborative note-taking and instructor-provided notes. The former strategy allows students to work together online in small groups to share the burden of note-taking as well as the benefits of the collaborative document they produce together. The latter strategy involves the course instructor providing students with a complete set of notes, freeing students cognitively to listen and make connections with the lecture content. However, research on these two approaches remains sparse, and thus far, no study has compared their effects on learning performance. Therefore, the present study compared the learning performances of 161 students divided into two treatment conditions within a flipped learning environment: one where students took collaborative notes and another where students received notes provided by the instructor. Quiz scores showed no differences between the two conditions, but measures of both group and individual writing quality were significantly higher in the online collaborative note-taking condition than with the instructor-provided notes.

Implications for practice or policy:

- To enhance students' recall, instructors should provide notes to students.
- To bolster students' ability to collaborate, instructors should have students take online collaborative notes.
- To enable students to improve and apply a skill, such as writing, instructors should have students take online collaborative notes.

Keywords: note-taking, instructor-provided notes, encoding-storage paradigm, collaborative note-taking, academic writing, recall

Introduction

Note-taking is a ubiquitous learning strategy employed by students when listening to course lectures. Research has consistently demonstrated the effectiveness of this approach in improving students' recall of course contents as well as their performance on learning assessment (Kiewra, 1985a; Mueller, & Oppenheimer, 2014; Peverly et al., 2012). Much of the literature on note-taking has employed the encoding-storage paradigm (Di Vesta & Gray, 1972) as a theoretical basis from which to understand the effects of note-taking on subsequent recall. According to this paradigm, encoding refers to the notion that by the act of writing down notes, students are able to imprint information to their long-term memories. Storage refers to the written record of notes produced in this way, which can be reviewed by the students at a later point in time as a supplement to their imperfect memories. Despite the benefits of encoding on students' long-term recall of course content, the process of writing down information while listening to a lecture and attempting to understand it is a cognitively demanding proposition, one which can ultimately overwhelm working memory (Jansen et al., 2017; Piolat et al., 2005). Meanwhile, numerous studies have shown that access to highly complete notes, that is, notes that contain a high proportion of relevant information from a course lecture, correlates positively with students' ability to recall information (Einstein et al., 1985; Raver & Maydosz, 2010).

Therefore, the question may be asked, “Is there a way to reduce the encoding burden on note-takers while still providing them access to high-quality storage?” Two approaches in this direction have been attempted in the literature with some success. The first is online collaborative note-taking, where small groups of students take notes within a shared online document, thereby dividing up the encoding burden while sharing the benefits of the storage they collectively produce. Studies have shown that students who take collaborative notes produce more complete notes and better learning outcomes than those who take notes individually (Courtney et al., 2022; Fanguy et al., 2023). The second approach is providing students with a comprehensive set of notes created by the course instructor, which students can use as received or can choose to add further annotations to if needed. Sample screenshots of each of these two types of notes can be seen in Figures 1 and 2 in the section The present study. Research has shown that students who receive instructor-provided notes earn higher grades on course assessments as compared to students who take notes on their own (Kiewra, 1985b; Raver & Maydosz, 2010). This may be because instructor-provided notes are likely to be more comprehensive than those students take by themselves, as students are known to omit important concepts when taking notes (Cukras, 2006). Moreover, instructor-provided notes greatly reduce or even eliminate the cognitive costs associated with encoding, and students can simply focus on listening to and understanding course lectures. Although both of these two alternative approaches to note-taking offer the advantages of higher-quality storage and lower cognitive burden from encoding as compared to traditional note-taking, there is a potential downside. As encoding has been shown to benefit students’ recall of learning content (Kiewra, 1987; Mueller & Oppenheimer, 2014; Peverly & Garner, 1990), drastically reducing or eliminating encoding may stymie these benefits.

However, the aforementioned learning benefits found in the literature on these two alternative forms of note-taking suggest that decreasing encoding while increasing storage may provide optimal effects to students’ learning performance. Thus far, the effectiveness of these two approaches has never been compared. Such a comparison might shed light on where the optimal zone of encoding and storage might lie in improving student learning performance, which would help to generate evidence-based recommendations for practitioners wishing to incorporate note-taking in their courses. Therefore, the present study compared the effects of online collaborative note-taking and instructor-provided notes on student learning outcomes in a 10-week graduate scientific writing course conducted in English in a large Korean university. Participants were divided into two treatment groups: the first treatment group took notes collaboratively in small groups of 3–5 students, and the second treatment group was given a complete set of notes created by the course instructor. The students’ performance on subsequent weekly quizzes and bimonthly writing assessments were assessed and compared in order to assess the effectiveness of these two alternative approaches to note-taking.

Literature review

Note-taking as a learning strategy

Taking notes is a widely subscribed learning strategy that students utilise to improve their ability to process (Bretzing & Kulhavy, 1979) and recall content from lectures (Aiken et al., 1975; Oefinger & Peverly, 2020; Tindale et al., 2007). Note-taking is nearly ubiquitous among university students when lectures are given (Bonner & Holliday 2006; Castelló & Monereo, 2005), and studies have demonstrated that note-taking promotes improved learning outcomes (Peverly et al., 2012). Students take notes in order to record content from their course lectures and to facilitate their review and reflection of those concepts (Boch & Piolat, 2005). In other words, notes provide students with an external storage of information that they can access at a later point in time (Boch & Piolat, 2005). As learners review their notes, such as when studying for an exam, they are able to internalise concepts from this external storage, committing them to their long-term memories (Kiewra, 1987).

Note-taking and exam performance

In addition to the creation of an external storage of information, the process of writing down notes allows students to make deeper connections with learning material. Research has shown that note-taking seems to reduce the burden on students' working memories when participating in learning activities, which better enables them to solve complex problems (Boch & Piolat, 2005). Moreover, the process of writing down key concepts from a lecture can also enable learners to remain focused on the content of the lecture, and such active engagement has been found to enhance students' understanding of the material and their subsequent learning performance on exams (Bohay et al., 2011). Learners who concentrate on the lecture and take notes on key concepts are better able to cognitively process the content, enabling deeper levels of understanding (Salame & Thompson, 2020). Through note-taking, learners are also able to build connections among concepts from the lecture, which increases their retention of the material when taking subsequent exams (Mayer, 1984).

Note-taking and academic writing

Research has shown that, as students take notes of higher quality, the quality of their academic writing also improves (Ju & Kim, 2020). Moreover, learners who write a larger quantity of high-quality notes exhibit better performance in composing essays that require synthesis, higher-order application and analysis of content (Waite et al., 2018). Benton et al. (1993) found that taking longer and higher-quality notes is correlated with improved writing quality when students were tasked with composing compare-and-contrast essays, as long as the students were able to refer to their notes while writing. Other research has shown that any type of note-taking is more beneficial to learners' ability to compose a coherent essay when compared to not taking notes (Slotte & Lonka, 2001).

Encoding-storage paradigm

The literature on note-taking generally describes a solo endeavour in which a student attempts to write down relevant information from a course lecture in an effort to improve comprehension and recall. The dominant theoretical framework for research on individual note-taking is the encoding-storage paradigm (Di Vesta & Gray, 1972). In this paradigm, *encoding* refers to the process of writing down concepts in order to imprint them into the long-term memory (Peper & Mayer, 1978). The written record created in this way is known to as *storage* (Di Vesta & Gray, 1972). Storage offers a further benefit to the learner, as it can be reviewed at a later point in time so that the learner need not be burdened with trying to remember every concept from the lecture (Mueller & Oppenheimer, 2014). A common measure of the storage quality of a set of notes is their completeness, which refers to the extent to which the notes represent concepts from the lecture (Boch et al., 2013; Kiewra & Benton, 1988). Storage usefully supplements the imperfect long-term memory during review sessions, such as when studying for exams (Kiewra, 1985a).

Problems with traditional note-taking

Despite the numerous benefits to note-taking, there are several issues that may prevent note-takers from obtaining the full benefit of this strategy to their learning. Studies have shown that students are often ineffective note-takers, as they frequently omit key concepts from lectures from their notes (Cukras, 2006; Hughes & Suritsky, 1994). Therefore, the external storage of information that students create through note-taking may be incomplete, impeding their ability to review course information at a later time. Moreover, the process of taking notes may also come with the significant cognitive cost of attempting to listen, write and comprehend simultaneously, which may be burdensome enough to overload learners' working memories in some cases (Jansen et al., 2017; Piolat et al., 2005). Therefore, the subsections that follow will examine two alternative forms of note-taking for reducing the amount of encoding students engage in while increasing their access to quality storage: collaborative note-taking and instructor-provided notes.

Online collaborative note-taking as a learning strategy

Note-taking does not necessarily need to be a solitary undertaking, and the emergence of online collaborative writing platforms, such as Google Docs, has enabled learners to take notes collaboratively within shared documents. From the perspective of the encoding-storage paradigm, collaborative note-taking is a learning strategy in which a group of learners divide the labour of encoding the notes and collectively share the resulting storage that is produced. Studies have shown that learners taking notes on their own may record only 11% to 70% of the information presented in a course lecture (Anderson & Armbruster, 1991; Hughes & Suritsky, 1994; Kiewra, 1985b). However, work has shown that when students take notes collaboratively in groups, their notes are considerably more voluminous and complete (Courtney et al., 2022; Fanguy et al., 2023), features which have been shown to be highly correlated with the extent to which learners retain information from a lecture (Haynes et al., 2015; Kiewra, 1985a). This occurs because the creation of a learning artefact of higher-quality leads to higher retention of learning content and better learning outcomes (Butson & Thomson, 2014). Work has also suggested that having more complete notes decreases the cognitive burden learners experience when attempting to recall instructional concepts (Hadwin et al., 1999) because they can divide up the task of taking notes and focus their attention on class material (Tindale & Winget, 2017).

Online collaborative note-taking and exam performance

Although online collaborative note-taking is still a relatively new area of research, a number of studies have shown beneficial results to this learning strategy. In one study (Orndorff, 2015), collaborative note-takers were found to achieve scores that were one letter grade higher than those of students who did not take collaborative notes, and end-of-semester surveys revealed that learners tended to share the workload of note-taking by performing defined roles within the groups, which Orndorff surmised may have contributed to improving the comprehensiveness of the notes. In another study specifically comparing the learning performance of individual and collaborative note-takers, collaborative note-takers earned higher scores on exams, but individual note-takers produced academic writing of higher quality, as assessed by their course instructors (Fanguy et al., 2023). Taken together, the findings of these two studies suggest that the division of labour among group members during note-taking may be double-edged: the division of labour may indeed free up cognitive resources for each learner to comprehend and remember the contents from course lectures, each constituent member of a group is required to write fewer notes than would be necessary if notes were taken individually. In summary, dividing up note-taking responsibilities can reduce the cognitive demands of note-taking but also may reduce opportunities for students to encode the content from the course lectures to their long-term memories.

Online collaborative note-taking and academic writing

With regard to writing performance, there is evidence that the greater the amount of information that students share with each other during collaborative learning experiences, the better their academic writing performance (Fanguy et al., 2023). Moreover, it has been suggested that more comprehensive collaborative note-taking processes prior to writing may result in higher-quality writing (Pospelova, 2021). Despite this, a study that compared the learning performance of students who had participated in collaborative note-taking and students who had taken notes on their own revealed that those who had taken notes on their own produced higher quality essays (Fanguy et al., 2023). Several reasons for this effect have been proposed: some learners may prefer to work on their own in certain situations (Pospelova, 2021); they may be negatively affected by the cognitive transactional costs engendered by collaboration (Kirschner et al., 2009); they may be distracted or annoyed by having their writing changed or deleted by a partner within a collaborative document (Blau & Caspi, 2009; Lund & Smørdal, 2006); or they may simply have had fewer chances to write notes and therefore less chance to practise writing (Fanguy et al., 2023).

Instructor-provided notes as a learning strategy

Although studies have shown that collaborative notes tend to be more complete than those taken individually (Courtney et al., 2022; Fanguy et al., 2023), none of the collaborative groups in either of those studies managed to record every salient point from the lecture; therefore, there was still room to improve the completeness of the notes. In order to ensure students have access to the highest quality notes, some have suggested that instructors should provide a complete set of notes to students (Raver & Maydosz, 2010; Volet et al., 2009). By doing so, instructors can ensure that students have access to a complete set of notes without overwhelming them with the cognitively challenging task of trying to write down every salient point from the lecture while listening to it. When students are not devoting mental effort to writing down notes, they may be able to focus more mental effort towards learning the instructional material by referring to the notes (Zambrano et al., 2018). For this reason, learners who have access to highly complete notes (such as those provided by an instructor) tend to score higher on measures of recall and attention to detail (Bui et al., 2013; Raver & Maydosz, 2010; Volet et al., 2009).

Instructor-provided notes and exam performance

The provision of notes from the instructor has shown positive effects on performance in adult learners taking quizzes and exams. Kiewra (1985b) found that learners who studied notes provided by the instructor scored significantly higher on delayed recall exams compared to learners who reviewed notes they had taken by themselves. A more recent study by Raver and Maydosz (2010) found that students who received a complete set of instructor-provided notes scored significantly higher than students who did not receive instructor notes, regardless of whether the notes were provided before or after the lecture.

However, one potential problem with instructor-provided notes is that students may engage in less encoding behaviour than they would when taking notes individually or in a group since learners with instructor-provided notes may choose not to take any notes of their own or may instead choose to take a few notes to supplement those provided by the instructor (Friedman & Fink, 1979; Gee, 2011). This concern seems to have been borne out by the results of a study by Barnett (2003), who found that learners who took notes on their own or who added their own notes to complete a set of partial notes provided by the course instructor showed better recall on exams than learners who received a complete set of notes from the instructor. Similarly, Katayama et al. (2000) compared the effects of providing partial or complete instructor notes to learners on immediate and delayed exams. The results suggest that although there was no difference between these two treatment conditions in terms of scores on fact or structure exams, students' scores on application exams were positively affected by the provision of partial (rather than complete) instructor notes.

Instructor-provided notes and academic writing

Most research on note-taking has focused on effects on students' exam performance, and to the best of my knowledge, there have been no studies yet on the effects of instructor-provided notes on students' ability to write academic essays. However, there are reasons to suspect that there would be numerous benefits to having access to instructor-provided notes, which tend to be highly complete since they are provided by the instructor who designs all lectures and subsequent assessment. For example, research has shown that students who have access to more thorough notes produce better quality academic writing as compared to those who do not (Wilson, 1999). Moreover, a study by Benton et al. (1993) showed that learners wrote longer and more coherent papers with the aid of their notes, and Benton et al. posited that the act of note-taking itself provided no learning benefits unless the learner reviewed them in the intermediate and long term. This suggests that the real benefit to note-taking is in the storage and the review of that storage rather than in the encoding process. If this were true, it would suggest that instructor-provided notes, which provide high-quality storage to learners with little or no encoding, may be very beneficial to learners' academic writing performance.

The present study

According to the encoding-storage paradigm, note-taking enhances students' recall of course information in two ways: through the encoding process, students are able to transfer information into their long-term memories and the storage of information created provides a useful supplement to students' memories. However, the encoding process can involve high cognitive costs, particularly when taking notes while listening to and attempting to understand the contents of a lecture. Furthermore, students are often limited in their ability to create notes with a high quality of storage, as they tend to leave out important information. Two strategies that have been proposed in the literature to address these issues are having students take notes collaboratively within shared online documents, as shown in Figure 1 and providing students with instructor-generated notes, as shown in Figure 2. The former strategy allows students to work together online in small groups to divide up the burden of note-taking while sharing the benefits of the collaborative document they produce together. The latter strategy involves the course instructor providing students with a complete set of notes that covers the salient points from their lecture, ensuring that students have an accurate and complete record of the information that was given so that students retain cognitive resources needed to make connections with the learning content.

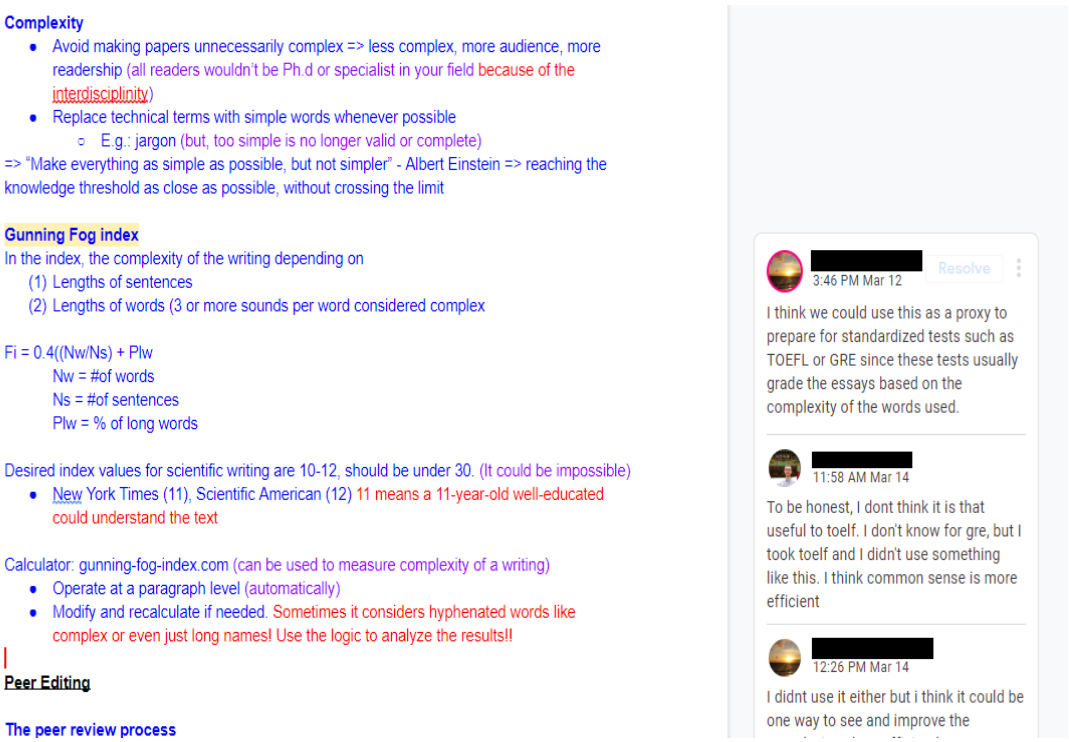

Figure 1. Screenshot of online collaborative notes: the written contributions of each of the three collaborators are denoted in blue, violet and red, respectively.

Complexity

Complexity

- Avoid making papers unnecessarily complex (simpler writings are more acceptable and approachable)
- Replace technical terms with simple words whenever possible.
  -Jargon : any kind of complex terminology.

"Make everything as simple as possible, but not simpler."
-Albert Einstein

Summary for complexity

1. Decreasing complexity can increase your readership (everyone can read your work)
2. Replace jargon with simple words to reduce complexity.

Gunning Fog Index

- In the index, the complexity of the writing depends on (1) the lengths of sentences, (2) the lengths of words
- Desired index values for scientific writing are 10-12:New York Times (11), Scientific American (12) (10-12 years old children with continuous education can understand the article)

$$F_I = 0.4((N_w/N_s)+P_{1w})$$

(N_w = # of words / N_s = # of sentences / P_{1w} = % of long words)

Try it

- Try copying and pasting a paragraph of your own writing into this Gunning Fog Index calculator (http://gunning -fog-index.com/)
- Try to keep your score below 30.

Figure 2. Screenshot of instructor-provided notes

From the perspective of the encoding-storage paradigm, online collaborative note-taking involves, on average, less encoding per group member and improved storage when compared to individual note-taking. Instructor-provided notes involve minimal or no encoding but excellent storage. Figure 3 provides an illustration of the amount of encoding effort required from learners versus the quality of storage produced in each of the following types of note-taking: individual note-taking, collaborative note-taking and instructor-provided notes. As shown in the figure, the amount of encoding effort on the part of the learner varies greatly in individual note-taking, and the amount of effort students expend in encoding the notes corresponds to the quality of the storage produced. However, prior work has shown that even high amounts of effort by an individual to encode lead to lower quality of storage of notes (Fanguy et al., 2023), as individual students tend to take rather porous notes (Jansen et al., 2017; Piolat et al., 2005). Collaborative note-takers tend to produce notes with higher storage quality compared to those of individual note-takers, and each member of the note-taking group has to expend less effort to encode (Fanguy et al., 2023). Instructor-provided notes involve little or no encoding effort on the part of the learner, and since the notes are provided by the instructor, they are generally highly complete and therefore can be considered to have high storage quality. Although there have been numerous studies regarding individual note-taking and its effects on learning performance, few have dealt with the effects of online collaborative note-taking and instructor-provided notes on student performance.

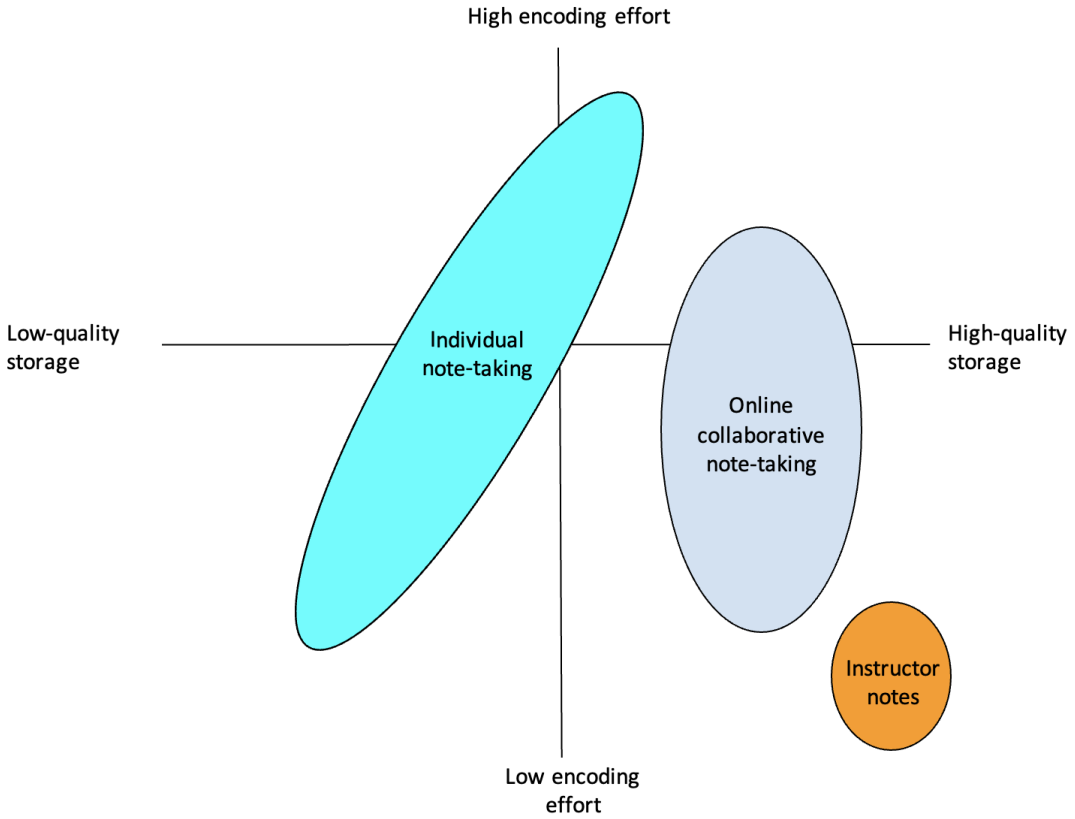

Figure 3. Three forms of notes compared in terms of the estimated encoding effort and storage quality

Therefore, the present study (*N* = 161) compared the learning performances of students enrolled in a graduate scientific writing course that was taught in English in a flipped format at a large Korean university. Ethical approval for the study was granted by an institutional review board at the institution where it was conducted. Participants were divided into two treatment groups: Treatment Group 1 took notes collaboratively online using Google Docs, and Treatment Group 2 was provided with notes by the course instructor. Student learning performance was measured in terms of recall and application of information contained in a unit of course lecture videos. Recall was assessed through a series of 10 online quizzes covering the content of these videos. Students' ability to apply the knowledge gained from the online lecture videos, which were designed to teach them how to write a scientific research manuscript, were measured by assessing the quality of students' group and individual writing assignments during the course.

The study was guided by the following research questions (RQ) with corresponding hypotheses (H):

- RQ1: Does online collaborative note-taking result in greater recall of course contents than instructor-provided notes?
- H1: Students in the online collaborative notes condition will have higher quiz scores.
- RQ2: Does online collaborative note-taking result in greater ability of student groups to apply knowledge they have gained through watching course videos as compared to instructor-provided notes?
- H2: Students in the collaborative notes condition will have higher group writing scores.
- RQ3: Does online collaborative note-taking result in greater ability of individual students to apply knowledge they have gained through watching course videos as compared to instructor-provided notes?
- H3: Students in the collaborative notes condition will have higher individual writing scores.

Methodology

Context

The objective of the scientific writing course was to train graduate students to effectively communicate their research findings through writing science or engineering research manuscripts for publication in academic journals. The course utilised a flipped format to minimise the need for synchronous class meetings, which can be challenging for graduate students who spend a significant amount of time in their research labs. Within this flipped format, students were required to watch a set of 4–9 online lecture videos each week on the course's learning management system (LMS). According to their aforementioned experimental grouping, students either took online collaborative notes on these video lectures or received course notes created by the course instructor. All students were then required to take an online quiz on the course LMS to test their comprehension of the lecture contents. After completing the online requirements, students participated in a weekly 90-minute synchronous Zoom meeting with the instructor, where they were expected to actively engage in discussions and demonstrate their comprehension of the online lectures' contents. Throughout the 14-week term, students were required to submit four group writing assignments, respectively corresponding to the Introduction, Methodology, Results, and Discussion & Conclusion sections of a journal manuscript. In addition, students submitted five individual writing assignments, each corresponding to a section of a research manuscript, including Introduction, Methodology, Results, Discussion & Conclusion, and Abstract. Both the group and individual writing assignments were assessed and graded by the instructor. More details about the course can be found in Fanguy and Costley (2021), and flowcharts of the instructional activities of the course are provided in Figures 4 and 5.

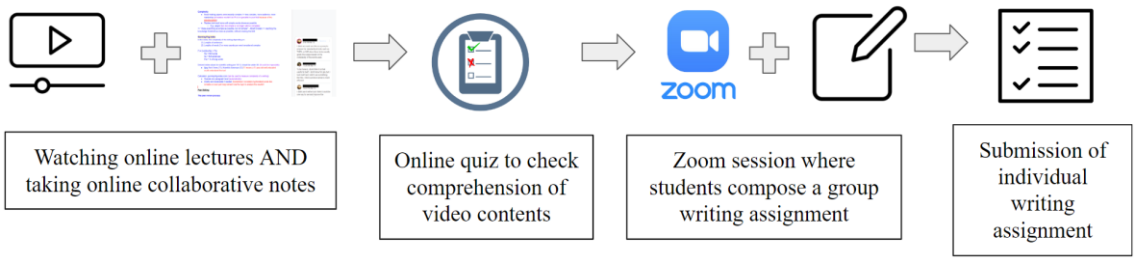

Figure 4. Flowchart of the course instructional activities undertaken by Treatment Group 1

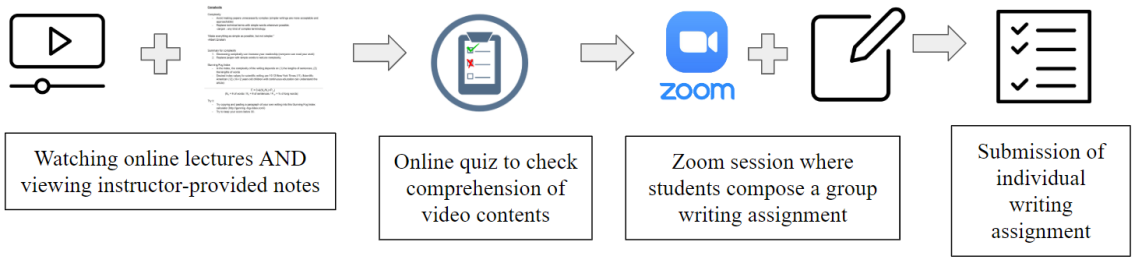

Figure 5. Flowchart of the course instructional activities undertaken by Treatment Group 2

Participants

The study involved 161 participants, consisting of doctoral and master's students majoring in science, technology, engineering and mathematics fields. The participants were divided into two treatment conditions.

In Treatment 1, participants were instructed to self-select into small groups of 3–5 students and to collaboratively take notes on online lecture videos provided via the course LMS during each instructional week of the course. The instructor checked the notes at the end of each instructional week to ensure that each member had at least contributed minimally.

In Treatment 2, participants were provided with 10 sets of notes created by the course instructor corresponding to each of the ten weeks of video instruction of the course. The instructor-provided notes covered all of the salient points from their lecture, ensuring that students had an accurate and complete record of the information that was given in the online lecture videos that were assigned for viewing during each instructional week.

Measures

The semester consisted of 10 online multiple-choice quizzes, one for each instructional week, aimed at evaluating students' ability to remember and comprehend the lecture video contents. Each quiz was composed of between 8 and 30 multiple-choice questions relevant to the respective week's lecture material. Each quiz had a time limit of 2 minutes per question and could be attempted only once. Each quiz was due by 6 pm on the Friday of its corresponding instructional week. Each quiz question had one or more correct answer options, and partial credit was given for questions in which students selected fewer than the total number of correct answer options. However, the selection of any incorrect answer option led to the entire question being marked as incorrect, with zero points awarded for that item. Each quiz was weighted equally and accounted for 3% of the students' overall course grade, with quiz scores accounting for 30% of the final grade. The Cronbach's alpha coefficients for each week's test scores were moderate, at .68, .62, .60, .69, .81, .64, .78, .58, .65 and .85, respectively, indicating that the quizzes are reasonably reliable measures of the instructional focus for each week. Further details regarding the test items and their relationship to the instructional content can be found at the following link: https://osf.io/5t8vw/?view_only=3514f73b64b1497a9948e1a544d565bc.

The course included four in-class group writing assignments that served as a proxy for a group's ability to apply knowledge gained during the course, corresponding to the following sections of an academic article: Introduction, Methodology, Results, and Discussion & Conclusion. The in-class group writing assignments required students to work collaboratively in groups of 3–5 students to complete an assignment that applied concepts they had learned from the lecture videos. The instructor scored each group assignment on a scale of 0–10 using rubrics adapted from the scientific writing rubrics proposed by Clabough and Clabough (2016). However, as these group writing assignments were used for practice, the scores given to the groups did not count towards the course point total.

Students were required to turn in five individual writing assignments during the semester, and these assignments served as proxies for an individual's ability to apply knowledge gained during the course. They were considered the primary assessment of the course and respectively corresponded to the following sections of an academic article: Introduction, Methodology, Results, Discussion & Conclusion, and Abstract. As with the group writing assignments, the course instructor scored each individual assignment on a scale of 0–10 using rubrics adapted from Clabough and Clabough (2016). The scores from the individual writing assignments accounted for 50 points of the total 100 grade points of the course.

Results

To gain a clearer perspective on the main variables examined in the study and the relationships among them, I calculated descriptive statistics and examined correlations between the main variables, as shown in Table 1. Group writing had a mean score of 33.43 out of a possible 40 points, and individual writing had a mean score of 42.09 out of a possible 50 points. The quiz score variable had a range of 13 to 28.69 points, with a mean score of 20.94 points. Individual writing has statistically significant positive correlations of 0.204 with group writing and 0.3074 with quiz scores, but quiz and group writing scores have a negative correlation of -0.014, which is not statistically significant.

Table 1
Descriptive statistics and correlations between the main variables

Variable	N	Min	Max	Mean	SD	Group writing	Individual writing	Quiz
Group writing	161	27	39	33.43	2.81	1		
Individual writing	161	32	50	42.09	3.88	0.204*	1	
Quiz	161	13	28.69	20.94	2.83	-0.014	0.3074*	1

*p = < .05. **p = < .01.

The correlations between the treatment conditions and dependent variables provide some insight into the effects of the type of notes students created and/or utilised on each treatment condition's subsequent group writing, individual writing and quiz scores. In Table 2, the mean scores across groups are presented with their standard deviations in parentheses.

Table 2
Main variable means by treatment condition

Treatment	N	Group writing	Individual writing	Quiz
Collaborative notes	84	34.14(2.72)	42.90(3.55)	20.93(2.82)
Instructor notes	77	32.65(2.72)	41.21(4.05)	20.96(2.86)

One-way ANOVA was used to investigate whether the differences in relationships shown in Table 2 are statistically significant. Table 3 shows that the between-group differences for both group writing ($p < 0.001$) and individual writing ($p = .005$) were statistically significant, but the between-group differences for quiz scores were not ($p = .94$). Statistical significance was determined by p values, which indicate the probability that the observed differences occurred by chance.

Table 3
One-way ANOVA results for the main variables

Variable		Sum of squares	Mean square	F	Sig.
Group writing	Between groups	89.61	89.61	12.14	0.000638
	Within groups	1173.8	7.38		
Individual writing	Between groups	115.69	115.69	8.04	0.00517
	Within groups	2287.9	14.39		
Quiz	Between groups	0.041	0.041	0.005	0.943
	Within groups	1284	8.076		

Discussion

The present study sought to compare the learning outcomes of students in two treatment conditions: one that involved online collaborative note-taking and another in which students were given notes created by the course instructor. The results showed that there was no significant difference between the two groups in terms of performance on quizzes, an assessment which served as a proxy for students' recall of course content. However, the online collaborative note-taking group performed significantly better on both group writing and individual writing assignments, which served as proxies for students' ability to apply the knowledge they had gained in the course at group and individual levels, respectively.

In terms of students' ability to recall information from the course lectures, as measured by quiz scores, no significant difference was found between the two treatment conditions, so H1 was not supported. This result provides support for an earlier study that found that the type and amount of notes students created and/or used had no effect on their subsequent recall performance as measured by exams of factual learning (Katayama & Robinson, 2000). According to the encoding-storage paradigm, the act of writing down notes enables the learner to move information from working memory to short-term memory, leading to improved recall (Di Vesta & Gray, 1972). Since the collaborative note-taking group was required

to engage in a substantial amount of encoding behaviours in order to create the notes (e.g., writing down notes and editing or responding to notes contributed by others), I assumed that they would exhibit better recall than that of the instructor-provided notes, who did not have to engage in encoding behaviour to produce their notes. However, the present results suggest that such encoding effort was not beneficial to students' recall, as there was no difference in their quiz scores. This result contradicts a study that showed that a note-taking process that involved both encoding and storage (as was the case in the collaborative note-taking condition) was superior to one that involved only storage (as was the case in the instructor-provided notes condition) in terms of learners' ability to recall lecture content (Kiewra et al., 1991). This finding also contradicts the interactive, constructive, active and passive (ICAP) hypothesis proposed by Chi and Wylie (2024), which predicts that students' learning increases as they become increasingly engaged with course content, moving from passive to active to constructive to interactive modes of learning. The ICAP framework would categorise collaborative note-taking as an interactive mode of learning because group members write down notes and respond to the written notes of their group mates, while reviewing instructor-provided notes would be classified as a passive mode of learning. Therefore, the ICAP hypothesis predicts that students who take notes collaboratively will recall more information than those who review instructor-provided notes, but this did not occur in the present study. Perhaps the benefits of encoding concepts from the lectures into the notes were washed out by the high cognitive cost associated with trying to listen, understand and write down all of the relevant information in the notes (Jansen et al., 2017; Piolat et al., 2005). This result suggests that when the goal of a lecture is to have students recall information, providing them with a complete set of instructor-generated notes is advisable, as there are no sufficient benefits to justify the cognitive costs of writing down notes while listening to a lecture.

However, with regard to group writing assignments, the online collaborative note-takers achieved significantly higher scores than those provided with instructor notes, so H2 was supported. Group writing assignments provide a measure of students' ability to apply information they have learned from the course at a group level. This finding is in line with work showing that when students collaboratively engage in more comprehensive note-taking processes, the quality of their subsequent writing improves (Pospelova, 2021). Moreover, the finding provides support for the aforementioned ICAP hypothesis, which predicts that the interactive learning activity of collaborative note-taking will lead to increased student learning compared to the passive learning activity of reviewing instructor-provided notes (Chi & Wylie., 2014). Another factor that may have contributed to the present result is that in Treatment 1, the note-taking groupings were maintained for all group writing assignments, so that the groups completing writing assignments in Treatment 1 were quite familiar with one another and probably learned a great deal about how to work together effectively on collaborative writing. Research has shown the benefits of collaborative writing increase over time (Costley et al., 2022), as students learn to mitigate the transactional costs associated with working with others in a group setting (Kirschner et al., 2009). Participants in Treatment 2 had fewer opportunities to work with their group writing members and may have been negatively affected by these cognitive costs.

The online collaborative note-takers also received significantly higher scores on individual writing assignments than did the instructor-provided notes group, so H3 was supported. This finding is also in line with the ICAP hypothesis, as a collaborative mode of learning should lead to increased learning as compared to a passive one (Chi & Wiley, 2014). As the course was designed to teach students how to write up the results of academic research into manuscript format, individual writing assignments were considered the primary assessment and accounted for half of the total course grade points. Consequently, the quality of students' individual writing assignments may be a representation of their ability to apply (rather than merely recall) the instruction they received from the course. A study by Katayama and Robinson (2000) found that students who were given a partially complete (≤ 50%) set of outline notes to fill in performed better on knowledge application tests than those provided with a complete (100%) set of outline notes. The authors surmised that this difference in performance was due to the effect of encoding, as the partial notes group needed to encode more of the instructional content than did the complete notes group, just as participants in the collaborative note-taking condition had to encode more information than did those in the instructor-provided notes condition in the present study. Thus, when

students are encouraged to actively generate some of the information they will study later, the information tends to have more meaning to them than when it is simply provided (Peper & Mayer, 1978). Although the present finding does not directly contradict work suggesting that having access to highly complete notes will improve writing scores (Benton et al., 1993: Wilson, 1999), it suggests that access to high-quality notes is not necessarily a sufficient condition for high-quality writing, as engaging in the encoding process with a group will improve individual writing performance further. Lastly, research has suggested that when students have fewer opportunities to write down notes, they have fewer opportunities to practise their writing skills, leading to lower writing scores (Fanguy et al., 2023). In the present study, students in the instructor-provided notes group had fewer opportunities to practise their writing skills since they were not required to write down notes, as was the case with the online collaborative note-taking group.

Conclusion

Taking notes while listening to a lecture is a beneficial learning practice that comes with a high cognitive cost, which may sometimes cause learners to miss key information. The present study investigated the learning effects of two alternative approaches that have been suggested as alleviating this mental strain while still enabling students to access highly comprehensive notes: students taking notes within small groups using shared online documents and students receiving notes created by the instructor of the course.

The results suggest three recommendations for practitioners. The first is that when recall of course contents is the goal of instruction, instructors should consider providing notes to students rather than requiring them to engage in online collaborative note-taking, as the former involves fewer transactional costs for an equal effect on learning performance. The second is that when course learning objectives include the ability to collaborate with others, such as through collaborative writing, online collaborative note-taking is advantageous, as it may help students become more familiar with one another and learn how best to interact when co-creating a learning artifact. The third is that when instruction is focused on improving a skill and applying knowledge that is learned in a course, such as academic writing skills, online collaborative note-taking is advised rather than providing instructor notes, as online collaborative note-taking seems to provide students with an appropriate amount of encoding, that is, less encoding than the sometimes-overwhelming amount required by individual note-taking but enough to enable deeper understanding of the content.

The present study fills an important gap in the literature on note-taking in comparing the effectiveness of online collaborative note-taking with instructor-provided notes. The comparison provided in this study will be useful to researchers in that it suggests something important about the value of encoding in note-taking: the benefits of encoding may not always be immediately apparent and may relate more to the eventual application of skills than to immediate recall of content. The present findings will also be of use to practitioners in that they provide meaningful suggestions on the conditions in which each approach to lecture notes will be of value to students' learning performance.

However, the present study has several limitations that must be addressed. The first is that the study does not account for additional annotations that may have been written by students in the treatment condition that received instructor notes. It is possible that students in this treatment condition took additional notes on their own or annotated the instructor notes, and this may have affected their learning performance in the course. Future research could account for students' annotations on instructor-provided notes, either by requesting students to turn in their copies of instructor-provided notes for examination by the researchers, or through qualitative research methods, by surveying or interviewing students about their approach to annotations and additional note-taking when provided with instructor notes. The second limitation of this study is that the completeness of the notes created by online collaborative note-takers was not assessed, so the completeness of the notes in the two treatment conditions could not be compared, which is another area for future research.

Despite these limitations, the present study goes some way in explaining the role and value of encoding notes when listening to online course lectures. The findings suggest that there may be an ideal zone in terms of the amount of encoding that will be beneficial for student learning outcomes, which would be somewhat less than the relatively demanding encoding levels of individual note-taking but more than the minimal levels of encoding that occur when students are provided with instructor notes.

References

Aiken, E. G., Thomas, G. S., & Shennum, W. A. (1975). Memory for a lecture: Effects of notes, lecture rate, and informational density. *Journal of Educational Psychology, 67*(3), 439–444. https://doi.org/10.1037/h0076613

Anderson, T. H., & Armbruster, B. B. (1986). *The value of taking notes during lectures* (Technical Report No. 374). University of Illinois at Urbana-Champaign. https://www.ideals.illinois.edu/items/17659/bitstreams/63448/data.pdf

Barnett, J. E. (2003). Do instructor-provided on-line notes facilitate student learning. *The Journal of Interactive Online Learning, 2*(2), 1–7. https://www.ncolr.org/jiol/issues/pdf/2.2.4.pdf

Benton, S. L., Kiewra, K. A., Whitfill, J. M., & Dennison, R. (1993). Encoding and external-storage effects on writing processes. *Journal of Educational Psychology, 85*(2), 267–280. https://doi.org/10.1037/0022-0663.85.2.267

Blau, I., & Caspi, A. (2009). What type of collaboration helps? Psychological ownership, perceived learning and outcome quality of collaboration using Google Docs. In Y. Eshet-Alkalai, A. Caspi, S. Eden, N. Geri, & Y. Yair (Eds.), *Learning in the technological era—Proceedings of the Chais Conference on Instructional Technologies Research 2009* (pp. 48–55). The Open University of Israel.

Boch, F., & Piolat, A. (2005). Note taking and learning: A summary of research. *Writing Across the Curriculum Journal, 16*(1), 8–28. https://doi.org/10.37514/WAC-J.2005.16.1.08

Boch, F., Piolat, A., & Olive, T. (2013). The completeness of students' notes: The influence of cognitive and metacognitive processes. *Learning and Instruction, 28*, 21–32. https://doi.org/10.1016/j.learninstruc.2013.02.003

Bohay, M., Blakely, D. P., Tamplin, A. K., & Radvansky, G. A. (2011). Note taking, review, memory, and comprehension. *The American Journal of Psychology, 124*(1), 63–73. https://doi.org/10.5406/amerjpsyc.124.1.0063

Bonner, J. M., & Holliday, W. G. (2006). How college science students engage in note-taking strategies. *Journal of Research in Science Teaching, 43*(8), 786–818. https://doi.org/10.1002/tea.20115

Bretzing, B. H., & Kulhavy, R. W. (1979). Notetaking and depth of processing. *Contemporary Educational Psychology, 4*(2), 145–153. https://doi.org/10.1016/0361-476X(79)90069-9

Bui, D. C., Myerson, J., & Hale, S. (2013). Note-taking with computers: Exploring alternative strategies for improved recall. *Journal of Educational Psychology, 105*(2), 299–309. https://doi.org/10.1037/a0030367

Butson, R., & Thomson, C. (2014). Challenges of effective collaboration in a virtual learning environment among undergraduate students. *Creative Education, 5*, 1449–1459. https://doi.org/10.4236/ce.2014.516162

Castelló, M., & Monereo, C. (2005). Students' note-taking as a knowledge-construction tool. *L1-Educational Studies in Language and Literature, 5*(3), 265–285. https://doi.org/10.1007/s10674-005-8557-4

Chi, M. T., & Wylie, R. (2014). The ICAP framework: Linking cognitive engagement to active learning outcomes. *Educational Psychologist, 49*(4), 219–243. https://doi.org/10.1080/00461520.2014.965823

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, 15*(1), A85–A93. https://www.funjournal.org/wp-content/uploads/2016/10/june-15-85.pdf

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*, Article 100831. https://doi.org/10.1016/j.iheduc.2021.100831

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*, Article 100873. https://doi.org/10.1016/j.iheduc.2022.100873

Cukras, G. A. G. (2006). The investigation of study strategies that maximize learning for underprepared students. *College Teaching, 54*(1), 194–197. https://doi.org/10.3200/CTCH.54.1.194-197

Di Vesta, F. J., & Gray, G. S. (1972). Listening and note taking. *Journal of Educational Psychology, 63*(1), 8–14. https://doi.org/10.1037/h0032243

Einstein, G. O., Morris, J., & Smith, S. (1985). Notetaking, individual differences, and memory for lecture information. *Journal of Educational Psychology, 77*, 522–532. https://doi.org/10.1037/0022-0663.77.5.522

Fanguy, M., & Costley, J. (2021). Creating a framework for understanding and defining flipped learning. *Journal of Educators Online, 18*(1), 91–104. https://doi.org/10.9743/jeo.2021.18.1.2

Fanguy, M., Costley, J., Courtney, M., & Lee, K. (2023). Analyzing collaborative note-taking behaviors and their relationship with student learning through the collaborative encoding-storage paradigm. *Interactive Learning Environments, 31*(7), 4057–4071. https://doi.org/10.1080/10494820.2023.2194329

Friedman, M. C., & Fink, L. D. (1979). Note-taking and learning: A summary of research. *Higher Education, 8*(1), 69–85. https://doi.org/10.1007/BF00137374

Gee, K. L. (2011). *The impact of instructor-provided lecture notes and learning interventions on student note taking and generative processing* [Master's thesis, San José State University]. SJSU ScholarWorks. https://scholarworks.sjsu.edu/cgi/viewcontent.cgi?article=4925&context=etd_theses

Hadwin, A. F., Kirby, J. R., & Woodhouse, R. A. (1999). Individual differences in notetaking, summarization, and learning from lectures. *Alberta Journal of Educational Research, 45*(1). https://doi.org/10.11575/ajer.v45i1.54623

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.

Hughes, C. A., & Suritsky, S. K. (1994). Note-taking skills of university students with and without disabilities. *Journal of Learning Disabilities, 27*(1), 6–9. https://doi.org/10.1177/002221949402700103

Jansen, R. S., Lakens, D., & IJsselsteijn, W. A. (2017). An integrative review of the cognitive costs and benefits of note-taking. *Educational Research Review, 22*, 223–233. https://doi.org/10.1016/j.edurev.2017.10.001

Ju, M., & Kim, J. (2020). 노트쓰기가 요약문 쓰기에 미치는 영향에 대한 질적 분석 (A qualitative analysis of the effect of note-taking on writing summary sentences). *Korean Language Education, 168*, 47–77. https://kiss.kstudy.com/thesis/thesis-view.asp?key=3754431

Katayama, A. D., Crooks, S. M., & Weiler, W. (2000, April 24-28). *Constructing and studying notes from on-line text: Why filling the blanks in a "partial notes" format may lead to higher performance on delayed higher-order tests* [Paper presentation]. Annual Meeting of the American Educational Research Association, New Orleans, LA, United States of America.

Katayama, A. D., & Robinson, D. H. (2000). Getting students "partially" involved in note-taking using graphic organizers. *The Journal of Experimental Education, 68*(2), 119–133. https://doi.org/10.1080/00220970009598498

Kiewra, K. A. (1985a). Investigating notetaking and review: A depth of processing alternative. *Educational Psychologist, 20*(1), 23–32. https://doi.org/10.1207/s15326985ep2001_3

Kiewra, K. A. (1985b). Students' note-taking behaviors and the efficacy of providing the instructor's notes for review. *Contemporary Educational Psychology, 10*(4), 378–386. https://doi.org/10.1016/0361-476X(85)90034-7

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

Kiewra, K. A., Benton, S. L. (1988). The relationship between information-processing ability and note-taking. *Contemporary Educational Psychology, 13*(2), 156–167. https://doi.org/10.1016/0361-476X(88)90019-2

Kiewra, K. A., DuBois, N. F., Christian, D., McShane, A., Meyerhoffer, M., & Roskelley, D. (1991). Note-taking functions and techniques. *Journal of Educational Psychology, 83*(2), 240–245. https://doi.org/10.1037/0022-0663.83.2.240

Kirschner, F., Paas, F., & Kirschner, P. A. (2009). Individual and group-based learning from complex cognitive tasks: Effects on retention and transfer efficiency. *Computers in Human Behavior, 25*(2), 306–314. https://doi.org/10.1016/j.chb.2008.12.008

Lund, A., & Smørdal, O. (2006, August). Is there a space for the teacher in a wiki?. In D. Riehle, & J. Noble (Eds.), *Proceedings of the 2006 International Symposium on Wikis* (pp. 37–46). Association for Computing Machinery. https://doi.org/10.1145/1149453.1149466

Mayer, R. E. (1984). Aids to text comprehension. *Educational Psychologist, 19*(1), 30–42. https://doi.org/10.1080/00461528409529279

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

Oefinger, L. M., & Peverly, S. T. (2020). The lecture note-taking skills of adolescents with and without learning disabilities. *Journal of Learning Disabilities, 53*(3), 176–188. https://doi.org/10.1177/0022219419897268

Orndorff, H. N., III. (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://isetl.org/ijtlhe/pdf/IJTLHE27(3).pdf

Peper, R. J., & Mayer, R. E. (1978). Note taking as a generative activity. *Journal of Educational Psychology, 70*(4), 514–522. https://doi.org/10.1037/0022-0663.70.4.514

Peverly, S. T., & Garner, J. K. (1990). Note-taking skills of college students with and without learning disabilities: A comparison study. *Journal of Learning Disabilities, 23*(9), 555–560. https://doi.org/10.1177/002221949402700105

Peverly, S. T., Sumowski, J. F., Bell, K. R., & Buchkoski, J. (2012). College students' notetaking and recall: Does instructor verbal clarity matter? *Contemporary Educational Psychology, 37*(2), 145–155. https://doi.org/10.1016/j.cedpsych.2012.02.003

Piolat, A., Olive, T., & Kellogg, R. T. (2005). Cognitive effort during note taking. *Applied Cognitive Psychology, 19*(3), 291–312. https://doi.org/10.1002/acp.1086

Pospelova, T. (2021). The collaborative discussion model: Developing writing skills through prewriting discussion. *Journal of Language and Education, 7*(1 (25)), 156–170. https://doi.org/10.17323/jle.2021.10748

Raver, S. A., & Maydosz, A. S. (2010). Impact of the provision and timing of instructor-provided notes on university students' learning. *Active Learning in Higher Education, 11*(3), 189–200. https://doi.org/10.1177/1469787410379682

Salame, I. I., & Thompson, A. (2020). Students' views on strategic note-taking and its impact on performance, achievement, and learning. *International Journal of Instruction, 13*(2), 1–16. https://doi.org/10.29333/iji.2020.1321a

Slotte, V., & Lonka, K. (2001). Note taking and essay writing. In P. Tynjälä, L. Mason, & K. Lonka (Eds.), *Studies in writing: Vol. 7. Writing as a learning tool* (pp. 131–143). Springer. https://doi.org/10.1007/978-94-010-0740-5_8

Tindale, R. S., Stawiski, S., & Jacobs, E. (2007). Shared cognitions and group learning. In V. Sessa & M. London (Eds.) *Work group learning: Understanding, improving and assessing how groups learn in organizations* (pp. 73–90). Psychology Press. https://doi.org/10.4324/9780203809747

Tindale, R. S., Stawiski, S., & Jacobs, E. (2007). Shared cognitions and group learning. In V. Sessa & M. London (Eds.) *Work group learning: Understanding, improving and assessing how groups learn in organizations* (pp. 73–90). Psychology Press. https://doi.org/10.4324/9780203809747

Tindale, R. S., & Winget, J. R. (2017). Learning while deciding in groups. In L. Argote & J. M. Levine (Eds.), *The Oxford handbook of group and organizational learning* (pp. 155–174). Oxford University Press. https://doi.org/10.1093/oxfordhb/9780190263362.013.42

Volet, S., Summers, M., & Thurman, J. (2009). High-level co-regulation in collaborative learning: How does it emerge and how is it sustained?. *Learning and Instruction, 19*(2), 128–143. https://doi.org/10.1016/j.learninstruc.2008.03.001

Waite, B. M., Lindberg, R., Ernst, B., Bowman, L. L., & Levine, L. E. (2018). Off-task multitasking, note-taking and lower-and higher-order classroom learning. *Computers & Education, 120*, 98–111. https://doi.org/10.1016/j.compedu.2018.01.007

Wilson, K. (1999). Note-taking in the academic writing process of non-native speaker students: Is it important as a process or a product? *Journal of College Reading and Learning, 29*(2), 166–179. https://doi.org/10.1080/10790195.1999.10850077

Zambrano, J. R., Kirschner, F., & Kirschner, P. (2018). The effect of the prior collaborative experience on the effectiveness and efficiency of collaborative learning. In J. Kay & R. Luckin (Eds.), *Rethinking learning in the digital age: Making the learning sciences count—Proceedings of the 13th International Conference of the Learning Sciences* (Vol. 1, pp. 112–118). International Society of the Learning Sciences. https://repository.isls.org/bitstream/1/478/1/13.pdf

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