

# The Effects of Collaborative Note-Taking in Flipped Learning Contexts

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While the benefits of shared note-taking during live lectures have been studied, the effects of shared note-taking in e-learning environments merit examination since such courses often feature asynchronous video lectures, allowing students to work together to construct notes over longer periods of time. A study (n=92) was conducted in the context of a flipped scientific writing course at a Korean university to investigate the effects of collaborative online note-taking on student learning. Students in the course were divided into two groups: members of the control were simply directed to view course videos and take notes individually, and members of the experimental group were asked to take collaborative notes in a shared online document. Student learning performance was measured through six online quizzes related to the course video lectures and through six related individual writing assignments. No differences were found in the learning outcomes of the control and the collaborative note-taking groups. However, significantly higher scores on related online quizzes and individual writing assignments were found in groups who took notes actively and for individuals who were major contributors to the group notes.

**Keywords:** Flipped classroom; online learning; collaborative note-taking; asynchronous instruction; online lecture videos

## Introduction

Students have come to acknowledge the benefits of online learning, including broader course offerings and greater scheduling flexibility, as well as the ability to control instructional pacing (Parsad, Lewis, & Tice, 2008). As with more traditional forms of instruction, many e-learning environments rely on lectures as a means of instruction. As lectures are often provided asynchronously in the form of online videos, students have the ability to view videos at their convenience, and may also pause, rewind, fast-forward, or skip ahead (Costley, Fanguy, Baldwin, & Han, 2018). Some research has suggested that a learner's ability to control the flow of information reduces the cognitive demands of note-taking, as students can listen attentively to segments of the video and pause to take notes instead of having to split attention simultaneously between watching the lecture and taking notes (Balfour, 2006; Davis, Connolly, & Linfield, 2009; Marchand, Pearson, & Albon, 2014).

While note-taking has traditionally been the task of an individual, cloud computing applications such as Google Docs and Microsoft Office Live allow students to collaborate on a single set of notes in a shared document. This collaboration may yield additional benefits in note-taking. Orndorff (2015) found that students divided the labor of taking notes in order to better concentrate on the lecture being delivered. Note-taking studies typically focus on synchronous note-taking taking place during a live lecture. However, as MOOCs increase in popularity (Chaplot, Rim, & Kim, 2015) and university lectures are increasingly hosted online (Dutton, Dutton, & Perry, 2001), students have the flexibility to view lecture content when they wish. As with note-taking in a lecture hall setting, the possibility exists for collaborative note-taking to take place, but the possibility of a different dynamic to that of Orndorff's study arises. That context is worth investigating, as it presents learners with the ability to free up cognitive resources while listening to lectures and taking notes by controlling the flow of information through pausing, rewinding, skipping ahead, etc. and by collaborating with classmates and dividing the labor of note-taking.

### **Note-taking and learning**

Note-taking during lectures in a traditional classroom setting is an integral, prevalent part of education (Chen, 2013) and has been since Greek times (Rabinow, 1984). Traditionally, pen and paper are used to record salient points and examples so that factual content and concepts can be stored, referred back to, and reflected on at a later date, particularly prior to tests and examinations. Researchers have distinguished two functions of note-taking: storage (Miller, Galanter, & Pribram (1960) in Di Vesta and Gray (1972)) and encoding (Di Vesta and Gray, 1972). The former is done so that the mind does not have to remember everything (Makany, Kemp, & Dror, 2009), while the actual physical process of writing information down is thought to imprint such knowledge on one's memory (Peper & Mayer, 1978). The latter is a cognitive process whereby the "learner has linked the material to his [or her] existing cognitive structure—he [or she] has made it meaningful" and therefore learning is facilitated (Di Vesta and Gray, 1972, p. 8).

The underpinning principle of cognitive load theory is that only a limited amount of mental effort can be exerted by an individual's working memory while trying to process knowledge at a specific time (Costley & Lang, 2017a; Tabbers, Martens, & van Merriënboer, 2004). Note-taking during a lecture requires a combination of "comprehension, writing, and learning" (Piolat, Olive, & Kellogg, 2005, p. 301). Chen (2013) reports that doing these three simultaneously is a challenge for students – the indication being that it puts great strain on working memory. Essentially, it is difficult to construct new schemas (germane load), which in turn has a positive effect on learning (Lange & Costley, 2018b), if one is attempting to comprehend and take down notes simultaneously. For these reasons, the process is termed "a high resource-consuming activity" (p. 297) by Piolat et al. (2005).

### **Advantages of collaborative note-taking**

The taking and utilizing of notes is not necessarily a lone pursuit by one learner, however, and a movement toward active learning in the late 1980s encouraged "enhanced lectures" by instructors that involved students comparing notes as part of a "pause procedure" (Bonwell, 1996). Ruhl, Hughes, & Schloss (1987) noted that short-term and long-term retention of facts improved significantly in participants in classes where pauses and clarification of notes in pairs took place. A recent study by Luo, Kiewra, and Samuelson (2016) also found that such pair work led to more original notes – that are content recorded prior to revision - being taken during lectures.

The advent of wireless internet and increasingly portable electronic devices has encouraged the use of laptops (Kay & Lauricella, 2011) and other electronic devices for note-taking in the lecture hall (Roberts & Rees, 2014). The benefits of using such equipment are that, for most people, typing is quicker than writing and involves less exertion. Electronic notes are also more easily edited, indexable, searchable, and stored (Weaver & Nilson, 2005). Collaboration is also facilitated as sharing can be done using a real-time, collaborative document such as a Google Doc, part of the Google Drive service. Google Drive enables the simultaneous writing and editing of a document by an almost unlimited number of people (Judd, Attebury, George, Marcum, & Montgomery, 2008). Such increased interaction between students has been shown to improve learning outcomes (Costley, 2016; Costley & Lange, 2016; Costley, Lange, & Han, 2016). A prior study by Orndorff (2015) found that those who collaborated to compile notes in live university lectures using Google Docs averaged almost one letter grade higher in their social science studies than those who did not. The division of roles also ensured notes were

comprehensive.

Recently, much has been made on social media and in academia of the practice of collaborative note-taking during lectures<sup>1</sup>. Such behavior – the digital sharing of one’s notes to the entire class – has its detractors and its supporters. The latter note the advantages of open source information and how sharing notes enables different perspectives to be voiced and considered. At the basic level, it has the potential to facilitate better note-taking, as individuals learn from the styles and approaches used by contemporaries. However, concerns have also been raised, and detractors claim that students will be less inclined to take notes in this manner if it is compulsory or they may skip class if they know comprehensive notes of lecture proceedings are available. A study by Kiewra (1988) (in Kiewra, 1989) found that students who skipped lectures but borrowed notes taken by those in attendance did comparatively as well on tests featuring the content as those who went to the lectures and took notes. Interestingly, students who borrowed notes even did better on synthesis tests – the suggestion being that the original note-takers were too focused on the physical act of note-taking to make connections between the material. The borrowers had no such constraints; neither would our less active note-takers, having been freed up cognitively to focus on bigger picture issues. While there may be benefits to borrowing notes, academic integrity issues may also arise if students deliberately or inadvertently use the words of other students in their essays<sup>1</sup>.

### **Note-taking in asynchronous online learning environments**

A distinguishing feature of e-learning environments is that instruction is usually delivered asynchronously, allowing students to access course videos online at their convenience. When watching instructional videos asynchronously, students can pause, rewatch, or skip over parts of a lecture as needed, which has been reported to positively affect student note-taking and understanding of the learning content (Bruff, Fisher, McEwen, & Smith, 2013; Costley et al., 2018a; Veletsianos, Pasquini, & Reich, 2016). There have also been several studies in which recordings of live lectures are provided to students online as a supplement, and students in these studies report better concentration during the in-class live lecture component of their courses since notes can be completed or expanded later when reviewing the recorded version of the lecture online (Balfour, 2006; Davis et al., 2009; Marchand et al., 2014). Studies note that the asynchronous presentation of course content may also yield benefits for learners with disabilities, as it allows them to access content at their own pace, which enables them to take better notes (Graves, Asunda, Plant, & Goad, 2011; Twigg, 2009).

While there are few integrated note-taking features included in the major MOOC platforms (Veletsianos, Collier, & Schneider, 2015) – edX has recently added a note-taking tool for the text elements of its courses (Pérez-Álvarez, Maldonado-Mahauad, Sapunar-Opazo & Pérez-Sanagustín, 2017) - several tools exist to facilitate the taking of notes in e-learning including, but not restricted to, Livenotes, DyKnow, eMargo, AOF, u-Annotate (Steimle, Gurevych, & Mühlhäuser, 2007), and EduNotes (Popescu, Stefan, Ilie, & Ivanović, 2016). VideoNot.es permits you to type your comments whilst a video lecture from either Coursera, edX, Khan Academy, or Udacity plays. What you write is time-stamped and can then be shared via Google Drive<sup>2</sup>.

With specific relation to e-learning, Blom, Verma, Li, Skevi, and Dillenbourg (2013) speak of online learners using “a shared note taking tool,” and participants in Veletsianos et al.’s (2015) study mention the importance of being able to share their notes with others while taking part in MOOCs. The authors of the study also claim that collaborative note-taking can maximize group and individual knowledge and interest in a subject, but warn that this practice could mean individuals fail to comprehend complicated ideas essential for knowledge construction.

### **The present study**

Research has shown that note-taking is an effective learning strategy that improves learner recall and comprehension of content. However, a key drawback of note-taking during instruction is that it may lead to cognitive overload due to the heavy strain on working memory created by trying to listen and write all at once

<sup>1</sup> Guertin, L. (2016, December 28). Student collaborative note taking during lecture - encourage or discourage? Retrieved from <http://blogs.agu.org/geoedtrek/2016/12/28/collaborative-note-taking/>

<sup>2</sup> Garza, F. (2016, January 26). How to take better notes during MOOCs. Retrieved from <https://www.springboard.com/blog/note-taking-apps/>

(Chen, 2013; Piolat et al., 2005). Collaboration when note-taking may help to reduce some of this cognitive burden by allowing students to play particular roles while taking group notes (Orndorff, 2015). Asynchronous instruction has also been shown to free up cognitive resources during note-taking by allowing learners to control the pace of instruction through lecture behaviors such as pausing, rewinding, fast-forwarding, and skipping ahead in a lecture video (Davis et al., 2009; Graves et al., 2011; Marchand et al., 2014; Twigg, 2009; Veletsianos et al., 2016). While studies have examined the respective benefits of collaborative note-taking and of note-taking in asynchronous learning environments, to the best of the authors' knowledge, none have examined whether these benefits apply when these situations are combined, i.e., when notes are taken collaboratively in asynchronous learning environments. This is a worthwhile concept to explore.

### **Purpose and research questions**

The present study examines the experiences of students (n=92) participating in flipped graduate-level scientific writing courses at a Korean university. "Flipped" in this context meant that students watched video lectures and took quizzes prior to classes where they practically applied what they had learned at home through collaborative writing activities (for more information about the collaborative writing activities, see Fanguy, Wang, & Baldwin, 2016). The aim of the study is to assess whether collaborative note-taking on online lecture videos yields benefits to student performance on related quizzes and individual writing homework assignments. This study examines the following research hypotheses:

- 1a. Students who are asked to take group notes perform better in their individual writing tasks.
- 1b. Students who are asked to take group notes will perform better on related online quizzes.
- 1c. Students who are asked to take group notes derive benefit from being a member of an active group.
- 1d. Students who are members of an active group must be active themselves to enjoy the benefits.

## **Materials and Methods**

### **Participants**

The present study monitored the note-taking of 92 graduate students from five sections of a compulsory scientific writing course at a science and engineering university. The students had a variety of majors, but all majors were in STEM fields.

### **Materials**

The video lecture content focused on the organization, grammar, vocabulary, and content expected of a typical academic journal paper (for more information about the course videos, refer to Fanguy, Costley, & Baldwin, 2017 and Fanguy, Costley, Baldwin, Lange, & Wang, 2019). Six online quizzes were used to test how much content was learned from the online video lectures.

### **Instruments**

The school's learning management system (LMS). Google Doc service.

### **Procedure**

The lectures for the course were delivered via videos posted on the school's learning management system (LMS). Students' ability to assimilate this information and incorporate it into their own written product thus acts as a proxy for learning in our study. Thirty-two students (from two classes) were split into groups of either three or four individuals depending on class size. These groups were asked to take notes together using a Google Doc within Google Drive created by the professor in charge of the class. The remaining 60 (from three classes) were advised to take notes individually. All students were informed of their right to opt out of the study at any time and/or to abstain from note-taking at their own discretion.

Students met for face-to-face class once a week to complete task-based activities that tested students' practical application of the content covered in the video lectures. A group assignment for each journal paper section

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required students to use the typical features, grammar, and language expected of that section. The assignment was submitted after class via the LMS and holistic feedback was provided by the instructor. It is of note that the note-taking groups were, for simplicity's sake, organized around the existing seating arrangements in week 5 of the semester; therefore, more often than not, the groups for in-class activities were identical to the note-taking groups.

Assessment during the course involved the writing of journal paper sections (i.e., the Introduction, Methodology, Results, Discussion & Conclusion, Abstract, and References) for the research that students were conducting in their laboratories. Students uploaded these assignments on the course LMS, and the instructor graded each submission on a scale of 0-10. These assignments were evaluated on the specific functions and features that should be respectively fulfilled and contained in the given section of a research manuscript. Language issues such as appropriate grammar and word choice were also assessed. Besides the numerical score, the instructor gave learners comprehensive feedback on their submissions, which included in-text comments, suggestions, and follow-up questions, and one to two paragraphs of terminal feedback for the entire assignment. These individual assignments accounted for a maximum of 60 points of the course total, with each writing assignment accounting for 10 points of the 100-point course total. In Tables 1-3 in the Results Section, the "Paper total" category refers to the combined score of these six sections of a research manuscript, with a maximum of 60 points.

Online quizzes were also part of the grading criteria and tested the application of knowledge gained from the online video lectures. They also served to measure student recall of the lecture content, which was necessary for actively taking part in the face-to-face problem-solving sessions and collaborative activities. There were a total of six online quizzes during the semester, with each comprising between 14 and 30 items. The quiz items were all multiple choice and allowed students to choose more than one correct answer. For quiz items with more than one correct answer option, partial credit was awarded for each correct answer selected, but no credit was awarded if an incorrect option was chosen, even if other correct answers were selected with it. Each quiz was worth 5% of the total course grade, accounting for a total of 30% of the total course grade.

### Results

The first step in this research was the comparison of the experimental treatment condition (group note-taking) with the control group. The results of this analysis can be seen in Table 1. The means of the students' total quiz scores, their total paper scores, and the constituent parts of the paper were all compared using independent sample t-tests. The results showed that there were no statistically significant differences between the control group and the group that took collaborative notes.

After comparing the two experimental conditions, further analysis was conducted on the 32 subjects who were part of the collaborative note-taking condition. Among the 32 students in the collaborative note-taking condition, only 13 were active note-takers; that is, they took notes on a regular basis throughout the semester. The 13 active note-takers were compared to the 19 students who were in the collaborative note-taking condition but took no notes. As can be seen in Table 2, there were many statistically significant differences between the note-takers and non-note-takers. Active note-takers achieved significantly higher scores on the quizzes and on their research papers. Furthermore, for each individual section of the paper, active note-takers performed better than those who did not take notes. Although not all sections of the paper had statistically significant differences, there is a clear pattern of the note-takers performing better than those who did not contribute to the collaborative note-taking process.

Table 1  
*T-test comparing the means scores between the treatment and control groups*

		<b>N</b>	<b>Mean</b>	<b>SD</b>	<b>Mean difference</b>	<b>p</b>
Quiz total	Control	60	22.30	3.71	-.581	.524
	Collaborative notes	32	22.88	4.66		
Intro	Control	60	7.33	2.07	-.600	0.223
	Collaborative notes	32	7.93	1.41		
Methods	Control	60	7.9	1.39	-.491	0.272
	Collaborative notes	32	8.39	0.84		
Results	Control	60	7.48	2.41	-.313	.518
	Collaborative notes	32	7.8	1.74		
Dis & con	Control	60	8.18	1.99	.264	.525
	Collaborative notes	32	7.92	1.70		
Abstract	Control	60	8.32	1.86	0.418	.107
	Collaborative notes	32	7.9	2.95		
Paper total	Control	60	39.02	6.60	-.522	.714
	Collaborative notes	32	39.54	6.24		

Table 2  
*T-Test comparing active note-takers to participants who took no collaborative notes*

		<b>N</b>	<b>Mean</b>	<b>SD</b>	<b>Mean difference</b>	<b>P</b>
Quiz total	Took no notes	19	21.2863	4.90169	-3.93445	.016
	Active note-takers	13	25.2208	3.18212		
Intro	Took no notes	19	7.67	1.690	-.655	.203
	Active note-takers	13	8.32	.773		
Methods	Took no notes	19	8.21	.924	-.458	.130
	Active note-takers	13	8.66	.623		
Results	Took no notes	19	7.84	1.404	-.746	.087
	Active note-takers	13	8.59	.695		
Dis & con	Took no notes	19	7.84	1.232	-.787	.047
	Active note-takers	13	8.62	.720		
Abstract	Took no notes	19	6.94	3.247	-1.759	.065
	Active note-takers	13	8.70	.674		
Paper total	Took no notes	19	38.49	5.478	-4.406	.005
	Active note-takers	13	42.90	2.503		

Finally, this study examined whether being a member of an active collaborative note-taking group had any effect on the dependent variables. Three out of a total of nine groups recorded no group notes in the Google Document. As can be seen in Table 3, membership in the six active note-taking groups had no effect on students' quiz results; however, it had a significant effect on the quality of the students' final papers, with students who were members of an active group scoring 15% more than those who were not members of an active group.

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Table 3

*T-Test comparing students who were members of active groups to those who were not members of active groups*

		N	Mean	SD	Mean difference	p
Quiz total	Inactive group	10	21.8440	5.24568	.403	-1.51373
	Active group	22	23.3577	4.41894		
Intro	Inactive group	10	7.29	1.752	.084	-.930
	Active group	22	8.22	1.162		
Methods	Inactive group	10	7.71	.918	.001	-.989
	Active group	22	8.70	.591		
Results	Inactive group	10	7.37	1.193	.012	-1.134
	Active group	22	8.50	1.067		
Dis & con	Inactive group	10	7.41	.663	.008	-1.092
	Active group	22	8.50	1.116		
Abstract	Inactive group	10	5.71	3.970	.003	-2.832
	Active group	22	8.54	1.027		
Paper total	Inactive group	10	35.48	3.563	.000	-6.978
	Active group	22	42.46	3.880		

### Discussion

The present research investigated collaborative note-taking and its relationship with students' learning outcomes. Students who participated in collaborative note-taking were compared to those who took notes individually in a flipped scientific writing class. The first finding of note was there were no statistically significant differences between students who were placed in the collaborative note-taking condition compared to those who took notes alone. That is, students gained no benefit to quiz or writing scores simply by being placed in a collaborative note-taking group, so Hypotheses 1a and 1b were not supported. Our assumption was that each collaborative note-taking group would produce at least some notes throughout the semester, but in three of the groups, no group notes were written. This may have been because the instruction to take notes was more of an advisory than a dictate. Personal preference for individual note-taking and/or traditional pen and paper may also have been the reasons for such behavior. When no group notes were produced, the interactional processes of group note-taking were unlikely to have occurred, precluding any learning benefits.

However, among the experimental group members, active note-takers performed significantly better than their non-note-taking counterparts when looking at their final piece of writing. Furthermore, individual section assignments written by active note-takers were better than those by non-active individuals (Table 2), with some of these differences being significant, providing support for Hypothesis 1d. However, Hypothesis 1c was rejected, as being a member of a group that had active members gave benefits to all members regardless of whether they actively took notes or not. Overall, students who were members of active groups scored significantly higher on the paper assignment as a whole than did those who were members of inactive groups.

Since actively produced collaborative notes were found to be beneficial, we examined the Google Documents they worked on in order to assess the types of interactions taking place therein. Interestingly, while Orndorff (2015) found that students took on roles and divided labor to produce collaborative notes in a synchronous live lecture setting, as anticipated, a different dynamic took place when participants collaborated to compile notes on video lectures viewed asynchronously. As there was a week between each face-to-face session, the student who viewed a particular video first tended to be the person who recorded the notes. The role-playing described

in the study conducted by Orndorff (2015) essentially became “turn-taking” in our study, where notes were added chronologically by whomever viewed the video lecture first and were rarely challenged or questioned. This may be explained by research on wikis - a similarly collaborative format - in which users were hesitant to alter one another’s work (Dalke, Cassidy, Grobstein, & Blank, 2007) due to what Blau & Caspi (2009) perceive to be psychological ownership.

In terms of contribution, and more specifically word count, typically two students (out of a maximum of four) wrote the lion’s share of the notes in active groups; this occurred in four of the six active groups. Twice the task was shared somewhat evenly by two of the group members, while on two other occasions, the ratio of work was 1:3. For the remaining two groups, one student wrote all the notes for one group, while the ratio of work distribution amongst members was 6:4:3:0 for the last group. Such behavior may be explained by Rienties, Tempelaar, Van den Bossche, Gijsselaers, and Segers (2009) who found that certain students – particularly highly motivated ones - are more likely to contribute to and lead group activities than those with lower levels of motivation. Concerns about one’s language skills (Hall & Buzwell, 2013) or even one’s perceived status within the group (due to seniority) (Webb, 1997) may have been the reason for less participation by others.

One possible reason for the benefits found from collaborative note-taking is that when learners face challenges in learning environments that exceed their cognitive abilities, the complementary and shared knowledge and skills of a learning group may be beneficial (Hung, 2013). Studies have also shown that working in groups leads learners to more meaningful engagement with the course material and more interesting and memorable educational experiences (Jonassen & Kwon, 2001; Rogers & Price, 2008). Such benefit is in keeping with our findings from Table 3, and while there are several possible explanations for these results, a common one is that scaffolding occurs between group members, which assists weaker learners. While involved in group work, less active individuals can ride the coattails of more active members and still achieve similar success (Mello, 1993). As was the case in the study by Kiewra (1988) (in Kiewra, 1989), the less active note-takers in our study may have benefitted from reading the notes of their more active group members, enabling increased focus of cognitive resources on bigger picture issues in the course.

While active note-taking led to clear benefits for those within the group, a potential constraint to this approach is that, due to psychological ownership, the teamwork that we witnessed was not as interactive as it had the potential to be. Students were reluctant to change or comment upon each other’s notes. This inactivity went against our expectations of lively interactions or the sharing of ideas and scaffolded language/knowledge support we had hoped for. The Google Documents platform offers collaborators a number of useful features for interaction, including comment threads, collaborative editing features, and even live chatting. However, we found no evidence that any of the students engaged in group note-taking used any of these features. This may be because students did not think that the material was challenging enough to merit a great deal of discussion or interaction on the notes they were taking. If so, the note-taking itself may have become an exercise in summary, something that is time-consuming and does not organically create the conditions for interaction. There was also a certain amount of presumption on our part that students would be familiar with Google Docs; however, comments made anecdotally by some participants suggest they were unfamiliar with the word processor’s features. We recognize now that we could have taught students to better use the collaborative software. Another likely explanation for the lack of interaction is that the students may have discussed the notes in the weekly face-to-face class meetings. If so, perhaps discussing the notes online would have seemed inefficient or redundant. It is also possible that simply dividing the labor of note-taking was sufficient to help students free up cognitive resources to focus on the higher-level concepts of the course that they were exposed to.

## Conclusion

In our study, collaboration was shown to benefit active note-takers and even passive members of active groups, due to the scaffolding and greater focus note-taking afforded them. While the results of the present study will be useful to instructors and content designers in flipped and online courses featuring online lecture videos, there were a number of limitations and areas for future research. More reliable results could be achieved with a greater number of participants. Furthermore, while the present study suggests possible reasons for the improved learning outcomes of group note-takers, a deeper textual analysis of students’ notes is needed to reveal the levels of contributions students make and the roles they play during the collaborative note-taking process.



Despite the aforementioned limitations, the results of the present study are valuable because, to the best of our knowledge, they represent the first attempt to measure the effects on collaborative note-taking in the context of asynchronous instruction (i.e., online lecture videos).

A common criticism of e-learning is that students may feel a lack of social presence from the instructor or fellow class members. Interactive learning has often been suggested as a means to increase interaction in e-learning environments and to mitigate feelings of isolation, but the act of viewing online videos remains, itself, a solitary one. The results of the present study suggest that online group note-taking provides a means of collaboration between students when viewing online videos, an otherwise isolating facet of e-learning.

### Compliance with Ethical Standards

The methods used in this study were approved by an Internal Review Board at the Korea Advanced Institute of Science and Technology and adhere to the ethics policies of the institution. All subjects in the study were informed of their rights and participated voluntarily.

### Conflict of Interest

The authors declare that they have no conflict of interest.

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