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THE EFFECT OF POSTGRADUATE STUDENTS' INTERACTION WITH VIDEO LECTURES ON COLLABORATIVE NOTE-TAKING

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ABSTRACT

Aim/Purpose	This paper aims to explore the effects of students' interactions with video lectures on the levels of collaboration and completeness of their group note-taking.
Background	There has been an increase in the amount of online learning over the last 20 years. With video lectures becoming an increasingly utilized instructional modality, it is essential to consider students' interactions with videos and the subsequent effect of those interactions on collaboration.
Methodology	This research used a combination of survey data about student interactions with video lectures and evidence of student-to-student interactions from a sample of 149 masters and Ph.D. students at a university in South Korea.
Contribution	To date, limited research has been conducted on the effect of student interactions with online instructional videos and that interaction's effect on collaborative note-taking. Past research has examined the effects of lecture-watching behaviors and collaborative note-taking separately, and this paper looks at their relationship with one another.
Findings	This paper has two main findings. The first is that interacting more with video lectures increases the amount that students interact with each other. The second is that these higher levels of interaction with videos do not impact the completeness of student note-taking.

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Recommendations for Practitioners	These findings of this paper suggest that instructors should encourage students to utilize active viewing strategies, as doing so will increase interaction among students, which will subsequently benefit their levels of collaboration.
Recommendations for Researchers	This research shows the value of drawing links between aspects of learner consumption of instructional media and other aspects of their learning, particularly collaboration.
Impact on Society	The importance of effective instruction and increasing collaboration in online learning is of great value now, particularly so, as much instruction is being delivered in online formats.
Future Research	Future research should seek further to understand the relationships between aspects of instruction and collaboration. More specifically, future research could look into clickstream data and collaboration.
Keywords	collaboration, group work, note-taking, video lectures, interaction

INTRODUCTION

We are reaching an era where many students' academic lives primarily center on the utilization of technological devices such as smartphones, laptops, tablets, or even watches, and instructional strategies need to be aligned with this new reality. Sauerteig et al. (2019) stated that the digital and technological world creates new opportunities for teachers and students to broaden their knowledge and skills in online learning contexts. In this context, online videos are the primary instructional medium in e-learning (Brame, 2016), which often provides the same content to learners through simultaneous online learning modalities (Mhamdi, 2017). Yen et al. (2018) asserted that the utilization of scaffolding and guided discussions could promote interactive online classrooms and peer support. Plaisance (2018) argued that online courses might outperform traditional teaching due to the rapid global growth in university students' enrollment in online courses. However, it has been argued that the online learning environments have constraints regarding technical skills, unreliable internet services (Esther et al., 2017), accessibility to technology, limited interaction between instructors and students, and the absence of facial and emotional expressions (Bakir et al., 2016).

Furthermore, there may be issues related to online videos, specifically, because they are the primary instructional modality in many online classes. Research provides evidence that learners may find the lack of feedback and engagement from an online video lecture challenging (Fiorella & Mayer, 2018). However, there is some evidence that these challenges can be resolved by dividing the lesson into segments paced by the student (Fiorella & Mayer, 2018). One way students themselves can use online lectures more actively is by engaging in video lecture-watching behaviors. According to Costley et al. (2020), selecting the content order, pausing, re-watching portions of the video lecture, looking away from the screen to listen more carefully, stopping listening from focusing on something on the screen, and scanning text to find specific information lead to improved student outcomes. This type of active use of online resources could be further fostered by engaging students in meaningful online interactions, which may lead to an improved online learning environment (Plaisance, 2018).

Literature pertaining to online collaborative learning strongly suggests that taking notes together allows students in online courses to collaborate and has a significant effect on students' learning development by enabling them to construct a meaningful context (Baldwin et al., 2019). Consequently, optimizing the implementation of note-taking is an effective strategy to assist in constructing shared knowledge in an online learning environment. A study by Nakayama et al. (2017) analyzed students' note-taking activity and their attitudes in a blended learning course. The results confirmed that, due to the participants' "out-of-class study" and "learning hours," their note-taking supports their overall learning performance in literacy. Strategic note-taking is a useful learning strategy that improves

problem-solving and self-explanation and leads to enhanced learning and understanding (Trafton & Trickett, 2001). Strategic note-taking also develops a meaningful interpretation of data and not just memorization and recall (Trafton & Trickett, 2001). It further supports active engagement with the content (Bohay et al., 2011). Additionally, the quality of note-taking, in the form of how complete they are, significantly impacts memory and test outcomes (Peverly & Sumowski, 2011) and increases the functionality of the learners' memory performance (Mueller & Oppenheimer, 2014).

THE PRESENT STUDY

With the latest development in online learning and the incorporation of technology in teaching, it is necessary to explore what underpins students' engagement in online learning environments. However, research into how students interact with video lectures and their online collaboration is limited. Specifically, a limited number of studies have focused on the effects of note-taking in e-learning environments while watching videos. There is a lack of research on the effect of instructors' online videos on student interactions and collaborative note-taking. Due to the importance of note-taking as a learning strategy and the absence of clarity about the lecture-watching behaviors that students engage in when taking notes online, this paper aims to explore the effects of students' collaboration and interactions with video lectures on the completeness of their collaborative note-taking.

The present study was conducted as a part of a flipped scientific writing class for graduate students at a large university in South Korea. The primary focus of the course was on how to plan, structure, write, and submit academic articles for scientific journals. Participating students were asked to collaborate in groups on weekly online note-taking to synthesize what they had learned of that week's video lectures, and their behaviors on the amount of collaboration and completeness when taking notes were examined. More specifically, this paper examines the correlations between these variables to establish whether there is an effect of video lecture-watching behaviors on the amount of collaboration and completeness when taking notes. This paper is guided by the following research questions:

1. Is there a relationship between video watching behaviors and the amount of collaboration students do?
2. Is there a relationship between video watching behaviors and note-taking completeness?
3. Is there a relationship between collaboration and note-taking completeness?

To further investigate video lecturing and students' collaboration, the hypotheses for the present study are as follows:

Watching video lectures leads to increased interaction due to collaborative effort.

1. Higher levels of video watching behaviors are positively correlated with higher levels of group collaboration.
2. Higher levels of video watching behaviors are positively correlated with higher levels of group work completeness.
3. Increased interaction is positively correlated with higher levels of group work completeness.

LITERATURE REVIEW

There is a seminal contribution of research delineating the desirability of collaborative note-taking. Much of this scholarship has focused on the effectiveness of note-taking or the benefits of video lecture instruction. However, little emphasis has been put on the effects of note-taking in e-learning environments while watching video lectures. A review of the literature regarding the concept and methods of collaborative note-taking in video lectures will be presented in what follows, and the synthesized findings will be discussed.

NOTE-TAKING

Research on note-taking goes back nearly 40 years (Di Vesta & Gray, 1972). Note-taking is well known as a general and observable index of learning development through the recording of information while reading, listening, or watching (Kiewra, 1983, 1985; Robinson & Kiewra 1995). Kauffman et al. (2011) affirm that note-taking serves two essential purposes: the first to encode noted data into long-term memory internally and the second to complete the notes and review them later as external storage (Kauffman et al., 2011). Scholars have investigated many aspects of note-taking, including collective reflexivity and social mobility (Khan et al., 2017). Khan et al. (2017) describe collective reflexivity as an active part of social mobility; for example, students use their mental capacity to explore methods and reflect on their understanding of a given content in social online learning environments. Furthermore, note-taking has been shown to be "an external cognitive aid," using the processed information from internal cognition of the human mind to perception and application (Makany et al., 2009) and, more commonly, as an assessment tool (Nakayama et al., 2017) of their learning performance. For example, students report on their various findings and concerns about the freshly processed material through discussions using language, emotions, sensations, and descriptions in a social context.

VIDEO LECTURES

The term tutored videotape instruction (TVI) was coined by Gibbons et al. (1977) to refer to the practice of distance students watching a videotaped lecture (VL) in small groups with a tutor. The focus of this research is based on the premise of cognitive load theory (CLT) by Chandler and Sweller (1991) and the cognitive theory of multimedia learning (CTML) by Mayer (2002), which both offer strategies for instructional operative multimedia resources. From a theoretical standpoint, CLT and CTML align with the perspective that multimedia resources should lessen the cognitive load and reduce the effort required of the learner's working memory (Chandler & Sweller, 1991; Mayer, 2002). Hence, student engagement with VLs is a critical aspect of online learning environments (Sherer & Shea, 2011). Furthermore, McLoughlin and Lee (2008) developed a framework to provide meaningful video instruction. This framework includes the three P's of pedagogy (participation, personalization, and productivity). In their study, students' collaboration in online video assignments allowed room for engagement in note-taking and reflection (*participation*), self-direction and self-assessment (*personalization)*, and creativity (*productivity)* in the dynamic learning collaboration.

VIDEO LECTURES AND NOTE-TAKING

A large number of studies (e.g., Lin et al., 2016; Watkins et al., 2015) have found that online communication with the participants limits the researchers' ability to observe the students' behavior in taking notes. However, such studies all noted that students tend not to take notes, even if a template is provided unless they are told to. Watkins et al.'s (2015) study results demonstrated that note-taking would help develop students' self-assessment as a study strategy. Further, in Lin et. al.'s (2016) examination of 73 Chinese EFL learners watching subtitles and taking e-notes, their result confirmed that video learning has a positive effect on promoting EFL learners' reading comprehension as it is associated with reducing the cognitive load. Thus, note-taking needs to be used as a support to develop students' academic performance.

Seminal contributions have been made to provide benefits of note-taking while watching video lectures. A study result revealed that the design of "NoteStruct led learners to write significantly more words than a free-form note-taking system, and a greater proportion of these words tend to be elaborations and interpretations, rather than verbatim copy-pasted text" (Liu et al., 2019, p. 5). This is an indication that note-taking can promote critical thinking and effective strategies for studying. Further, Baldwin et al. (2019) argued that active note-takers outperformed their non-note-taking partners in their final piece of writing. Stefanou et al. (2008) and Veletsianos, Collier, and Schneider (2015)

confirmed positive outcomes regarding online note-taking in the college classroom as evidence of generative and productive learning.

Collaboration and Product Completion

One way of understanding the quality of group work (Brindley et al., 2009) when it comes to group note-taking is how complete the notes are (Ruhl & Suritsky, 1995). Completeness, in this sense, is the degree to which the notes reflect the content learners have been presented with. There is some debate about how group interactions might affect student note-taking and the completion of tasks. Some research suggests that specific clusters of group work behaviors (e.g., "divide and conquer" strategies), where members do not interact much and split tasks up to different members, lead to a more complete final product (Yim et al., 2017). In the light of reported studies on note-taking effectiveness in productive learning, it is conceivable that learners' levels of communication can affect the learning and quality of the completed group completed (Rienties et al., 2009). This may be because groups that interact more will be able to focus more on the details of the task and produce a more comprehensive final product (Carlsmith & Cooper, 2002). It may be the case that high-quality learning products, such as more complete notes, are more relevant to learning than a high level of group interaction, though it is hard to differentiate these two processes (Barron, 2003). Specifically, high levels of engagement are correlated with high levels of group performance (Springer et al., 1999).

The Effects of Online Video Lectures on EFL Students' Attitudes and Performance

Chen and Wu (2015) examined how varied VL forms influence student performance. Specifically, their study analyzed how three frequently used VL types (lecture capture, voice-over presentation, and picture-in-picture) impact the constant attention, feeling, cognitive load, and learning outcomes. Data collection uses a quantitative two-factor experimental design that contains brainwave detection, emotion-sensing tools, cognitive load measures, and learning performance test sheets. The results indicated that while the three video lecture types develop learning performance, learning performance with lecture capture and picture-in-picture types outperformed the voice-over type. The findings of their study notably complemented the results of studies by Danielson et al. (2014) and Sherer and Shea (2011) in which they argue that students' contribution to online videos increases their engagement in classroom discussions and activities and supports them in innovatively designing and selecting online VLs.

In the same line of thought, Giannakos et al. (2016) utilized a questionnaire study to explore 40 students' responses to a video-based online engineering course. Results from the study showed that several students indicated that the obtainability of the VLs permitted them to have control of the lectures by going back to review the resources learned or a specific desired material at any given moment. The result suggests that VL patterns (style and duration) play an imperative role in students' learning attitudes. Similarly, Imelda et al. (2019) confirmed the positive effects of VLs on enhancing the writing skills of Indonesian English as a foreign language (EFL) learners. Their results also indicated that students were confident and had more control in English writing. Imelda et al. used the results of pre- and-posttests to show proper student engagement and a higher level of interest in the English language and increased collaboration between the groups. Likewise, Mohammadian et al. (2018) confirmed that integrating VLs in a high school classroom has a considerable effect on Iranian EFL learners' English reading comprehension. The results of both studies are congruent as they conclude that VLs should be promoted in EFL classrooms because of the positive effect on the four essential language skills (speaking, reading, writing, and listening).

Moreover, a study conducted by Scagnoli et al. (2019) on students' perceptions of online video-lecture classes reported that students who find VLs beneficial are mainly satisfied because it raises their independence and authority of their learning progress. The study also confirmed that video resources benefit students in producing an emotional connection with the topic covered, with the instructor,

and with their peers upon collaboration. Furthermore, a study by Bonafini et al. (2017) focused on how student engagement with forums and videos can predict their achievements in massive open online courses (MOOC). Students' commitments are constructed by self-organizing their contribution toward their goals and interests. The results demonstrate that students who use VLs demonstrate more information acquisition than critical thinking. Bonafini et al. suggest that educators use discussion prompts that support students' concerns and implement interactive videos to help develop personalized learning experiences and encourage learning engagements. In the same line of thought, a study conducted by Osman et al. (2016) examined Malaysian EFL college students' interaction and engagement in an online VLs. The results of this questionnaire demonstrated that the usage of VLs helped students to predict the lesson's end-result, thereby providing these students with an advantage compared to traditional learners. The study recommended using VLs as only a tool and not as a tutor because solely relying on VLs could hinder students' interactions with peers, materials, and lecturers.

The utilization of *flipped classrooms* has been discussed by a significant number of authors in literature. Zainuddin and Perera (2019) described the flipped classroom as "often synonymously associated with using videos to replace the conventional classroom lecture, which is mainly practiced in blended learning environments" (p. 115). The flipped classroom commonly concentrates on student engagement and active learning by employing differentiated learning instructions during the in-class time. Several comparative research studies (Alwehaibi, 2015; Guy & Marquis, 2016; Sohrabi & Iraj, 2016; Zainuddin & Perera, 2019) explored EFL learners' performance using instructional videos and podcasts instead of traditional teaching. The researchers examined this by a traditional classroom setting and a flipped classroom setting where they would watch educational videos that each contained the same educational content. While these review studies arrived at similar conclusions (the flipped classrooms scored higher in student engagement), the further emphasis was given to report on the benefits of the flipped classroom including students' level of commitment and satisfaction (Guy & Marquis, 2016), a significantly positive influence on EFL students' theoretical content understandings (Alwehaibi, 2015), development of problem-solving skills and an improvement in academic achievements (Sohrabi & Iraj, 2016), and a promotion of critical thinker and autonomous learners (Zainuddin & Perera, 2019).

As has been previously reported in the literature, research by Ahn and Bir (2018) that suggested practical tools for videos lecturing in large hybrid courses, by Altınay (2017) that offered evaluating tools for peer learning and assessment in online collaborative learning environments), and by Brame (2016) that provided guidelines to maximize student learning from video content. Previously discussed research affirms that students' learning outcomes improve with the increased usage of VLs and multimedia incorporation. The development is not only on students' learning outcomes but also on students' engagement, interactivity, and productivity. Nevertheless, Hastie et al. (2010) argued that current multimedia lectures (i.e., videos) lack interactive activities that would help students become more engaged in interaction. Additionally, research conducted by Ahn and Bir (2018) featured a flipped class, which included students watching a video before class and then having an assessment to check their understanding during class. Further, research by Li et al. (2014) suggested that instructors find a balance between video interaction and the amount of collaboration in a synchronized flipped classroom environment. However, the results reported that students perceived VLs as a destructive process as the content lacks clarity and intriguing features. To meticulously create interactive learning activities for practical learning, Hastie et al. (2010) recommended that instructors utilize a collective or a combination of effort, from mainly the discussion forums, correlated to the content of VLs. The research findings revealed that students have better achievement in recognizing and memorizing what is being taught when exposed to interactive VLs, which eliminates stress and cognitive burden.

Due to the importance of note-taking and the absence of clarity about the behaviors that students engage in when taking notes online (Sherer & Shea, 2011), this research aims at investigating the

effects of students' collaboration and interactions with video lectures on the completeness of their collaborative note-taking.

METHODS

CONTEXT AND PROCEDURES

The course took place over a 14-week period, with 10 weeks of face-to-face meetings and online video lectures (4 weeks of online classes lost due to assessment and administration). In regard to the online note-taking, students were given the opportunity to make their own groups on the first day of offline classes. The groups were made up of 3, 4, or 5 members who were asked as a part of their grade to complete the collaborative notes based on the week's lectures. Each week, students watched four or five online lecture videos on the course learning management system (LMS). The shortest video was 7:06, and the longest video was 24:50, with an average video duration of around 12 minutes. The collaborative notes were taken in 10 Google Documents shared among the course instructor, teaching assistant, and the group members, and each shared note-taking document corresponded to the videos of 1 of the 10 instructional weeks. Individual group members were given a score of 1 or 0 for their participation in group note-taking, with a score of 1 awarded for any meaningful content (even just one relevant phrase) being added to the collaborative notes and a score of 0 being given for nonparticipation. These scores were totaled for the 10 note-taking weeks of the course to account for 10% of the total course grade. In order to gather demographic data and information about students' video watching activities, a survey was given at the end of the semester, including an institutional review board (IRB) form that corresponds with this research. Participation in this study was, in accordance with the IRB, without incentive and voluntary.

The present study was conducted as a part of a flipped scientific writing class for graduate students at a large university in South Korea. The primary focus of the course was on how to plan, structure, write, and submit academic articles for scientific journals. The classrooms were taught using *flipped classrooms*, a strategy that aims at engaging students more with the classroom materials in an online collaborative method rather than only attending lectures during class time. The flipped classroom was completed by providing the students with tasks to be completed in the classroom and tasks to be completed online. During the weekly face-to-face sessions (75 minutes), students primarily engaged in two different activities: the first was a collaborative writing activity, and the second was peer-editing. The collaborative writing activities involved writing a document based on varied research scenarios, which corresponded to a section of an academic paper (introduction, methods, results, discussion, and conclusion). The online sessions, which were completed asynchronously by the students, involved watching video lectures on the course LMS related to a variety of topics, including, but not limited to, the structure and format of an academic paper as well as writing style and grammar issues. Students were asked to collaborate in groups on weekly online note-taking to synthesize what they had learned from that week's video lectures using their interpretation of new information and concepts. Students were also assessed online using quizzes on their collaborated notes from the watched videos.

PARTICIPANTS

This study involved nine-course sections of the Scientific Writing course, all of which were taught by the same instructor, with a total of 161 students. However, 12 subjects did not give permission to participate or did not complete the parts of the survey needed for this study and were therefore removed from the subsequent analysis. This left 149 (93%) participants from whom the following descriptions, tables, and analyses were generated. Prior to their admission to the university, all students were required to pass the TOEFL exam with an upper-intermediate and advanced English level. There were 113 (76%) masters students and 36 (24%) doctoral students. All participants were in science, technology, engineering, and math (STEM) fields, with a variety of majors being represented.

MEASURES

Lecture behaviors

In order to assess students' lecture behaviors while watching online videos, three following Likert-style items were used: (1) *While watching videos, I sometimes skipped ahead of boring or familiar content to parts I find more useful or interesting,* (2) *I sometimes had to pause the video to read something on the screen,* and (3) *I had to rewatch some parts of the lecture to fully understand it.* Students were requested to indicate how strongly they agreed with these statements by selecting an answer on a Likert scale between 1 and 7, with 1 being "strongly disagree and 7 being "strongly agree." This instrument was first developed and used in previously published research in Costley et al. (2018, 2020). As detailed in these studies, to create the instrument, the authors consulted with five students taking online courses that contained video lectures in order to discuss lecture-viewing strategies the students might employ when trying to better understand the content of the videos. The three Likert-style items used in the present study covered common strategies that all the students agreed were likely to be used to increase their understanding while viewing course videos. The Cronbach's alpha for the lecture behaviors construct was .801. This variable was measured at the level of the individual and included in a survey that students completed at the end of the semester.

Collaboration

To measure collaboration, a variety of values were used that were combined into one index based on the work of Fanguy and Chang (2020). This index included four indicators to measure the amount of learner collaboration: (1) the number of sessions in which the student logged in, (2) turns taken by the student, (3) edits of others' work, and (4) volume of words. *Sessions* were measured by how many times the students logged into Google Docs to take notes. A *turn* was measured from the first word a student wrote to the first word that the next student wrote or the end of the set of notes. *Edits* were measured by looking at the amount of text that one student deleted or wrote over the text of another. *Volume* was the total amount of words that the student wrote into the document. To extract the data from Google Docs, a macro for reading the variables was used. After extraction, as the individual items were very different in terms of their means, the individual items were converted into standardized values that were then summed to create a *total collaboration* score for each of the 10 weeks of group notes. In this way each individual variable had the same weighting towards the amount of total collaboration. This total amount of collaboration score was different for each individual in every group.

Completeness

To measure completeness, each weekly set of notes that each group produced was assessed as to its level of "completeness." These completeness scores were generated by comparing the notes taken to a rubric that outlines the key points presented in the online video lectures. This rubric is explained in more detail in Costley and Fanguy (2020). Simply speaking, the list of key points raised in the lectures was compared to the corresponding group notes students produced, with each point on the rubric being either a "1" if the point is covered or a "0" if the point is not covered. There was a variety in the number of key points covered each week, ranging from 36 to 256 different points. For this reason, each group's weekly scores were turned into standardized values, and then each week was summed together for analysis. Completeness was initially checked by a teaching assistant, then rechecked by the instructor. The instructor then rechecked the assistant's work; there was a small but acceptable difference (less than 1%) in their scoring. Each week's completeness scores were checked for internal reliability with all Cronbach's alphas being in an acceptable range (between .837 and .978). The scores for completeness were at the level of the group, with all members of the group getting the same score for each week.

RESULTS

The first step in the analysis was to look at the correlations between the amount that students interacted with the video lectures and the levels of collaboration and the levels of completeness. As can be seen in Table 1, the amount that students interacted with videos had a moderate positive statistically significant relationship (.293) with the levels of collaboration. This shows that students who engaged in more video interaction were more likely to engage in higher levels of collaboration. However, there was no statistically significant correlation between video interaction and levels of completeness. This and subsequent analyses were conducted at the level of the individual with each individual's video interaction score compared with their individual collaboration score and group completeness score. An analysis was done at the level of the group as well, which found very similar results as those that are presented in the current study.

Table 1. The relationship between interacting with video lectures and levels of collaboration and completeness

	Collaboration	Completeness
Video interaction	.293**	-0.001

Following this, three groups (high, middle, low) were generated from the video interaction scores. To create the three levels of groups, the students were ordered by their video interaction scores. The bottom 33.3% were considered the low group, the middle 33.3% were considered the medium group, and the top 33% were considered the high group. There were some cases whereby two learners had the same scores at the dividing lines between the groups. In those cases, learners were put into the higher group. As can be seen in Table 2, the high grouping of video interaction had a greater mean score than the medium grouping, and the medium grouping scored more than the low grouping. ANOVA revealed that the differences between these groups were statistically significant. The same process was applied to completeness with a different result. Table 2 shows that there were no significant differences between the high, medium, and low groupings of video interaction when it came to completeness.

Table 2. Mean of collaboration and completeness by video interaction level

	Video interaction level	**N**	**Mean**	**SD**	***p*-value**
Collaboration	Low	52	-1.0472	3.62752	.001
	Medium	48	-0.9381	3.35643	
	High	49	2.0303	5.16371	
	Total	149	0	4.33537	
Completeness	Low	52	0.2133	4.66772	.278
	Medium	48	-0.6233	4.72286	
	High	49	0.261	4.62967	
	Total	149	0	4.66098	

To look more deeply at the relationships between the high, medium, and low groupings of video interaction, the Scheffe test was used. The Scheffe test is a post hoc test of ANOVA that looks at the differences between groups on the basis of their levels of collaboration. As can be seen in Table 3, the low and medium video interactivity groups were very similar, and the difference between them was not statistically significant. However, the video interactivity high group had a higher collaboration mean than the lower and medium group. This difference was statistically significant.

Table 3. Scheffe test comparing interacting with videos group mean collaboration scores

(I) vid_inter_groups	(J) vid_inter_groups	Mean Difference (I-J)	Std. Error	*p*-value
Low	Mid	-0.10909	0.82503	0.991
	High	-3.07757*	0.82064	0.001
Mid	Low	0.10909	0.82503	0.991
	High	-2.96848*	0.83706	0.002
High	Low	3.07757*	0.82064	0.001
	Mid	2.96848*	0.83706	0.002

* The mean difference is significant at the 0.05 level.

Finally, the relationship between collaboration levels and completeness was examined. As can be seen in Table 4, there is a moderate statistically significant positive relationship (.357**) between the amount of collaboration students engaged in and how complete their notes were. This shows that as the amount of collaboration students engaged in increased, they started producing more complete notes.

Table 4. Relationship between collaboration and completeness

		Collaboration	Completeness
Collaboration	Pearson correlation	1	.357**
	Sig. (2-tailed)		0.001
Completeness	Pearson correlation	.357**	1
	Sig. (2-tailed)	0.001	

** Correlation is significant at the 0.01 level (2-tailed).

DISCUSSION

The present study examined students' note-taking behavior in online lectures. Specifically, the study investigated the relationship between the amount that students interacted with the video lectures and the levels of collaboration and the levels of completeness. Collaborative notes were looked at from two perspectives, the first was the amount of collaboration learners engaged in, and the second was how complete the notes were. As shown in the results, the video interactivity high group had a higher collaboration mean than the lower and medium group. This result is similar to the result of prior research conducted in a similar context (flipped classrooms) by Li et al. (2014) that showed that

students' collaboration in watching videos increased their interest levels of collaboration, which was measured through their engagement in learning within study groups.

The importance of this relationship between video watching and the amount of collaboration extends beyond the classroom limits in which it might develop learners' social and independent skills. For example, Brindley et al. (2009) reported that learners' participation in group projects has positive effects on enhancing the sense of community, cumulating digital competency skills, and developing learning outcomes. Taking this into consideration, instructors should connect their practice and learning objectives for enhancing their social, personal, and interpersonal skills (Brindley et al., 2009). However, Danielson et al. (2014) argued that, unless lecturers are well-structured and meaningfully contextualized (i.e., videos that promote guessing meaning from context), video lectures can hinder students' learning. Thus, the significance of providing meaningful video instruction (Danielson et al., 2014; McLoughlin & Lee, 2008) helps determine the level of collaboration, engagement, and productivity in note-taking and reflection.

The current study is in congruence with the discussed theoretical framework (CLT) by Chandler and Sweller (1991) and (CTML) by Mayer (2002) in which it explicates the value of how students engage with online materials and how this engagement influences their collaboration; both of which are of value to the field of education technology as there is a lack of research into student content engagement and collaboration (Gokhale & Machina, 2018; Imelda et al., 2019; Mohammadian et al., 2018). Furthermore, the connection between online video lectures and students engagement is described by Sherer and Shea (2011), in which they argue that "online video's versatility, accessibility, breadth of content, and up-to-date materials afford both instructors and students opportunities to shape and contribute to course content and increase student engagement in classroom discussions and activities"(p. 58). The previous research findings are consistent in showing that diverse video lectures (e.g., ranging from live lectures, recorded video lectures, and voice-over presentations to picture-in-picture), with the latest development in online learning and the incorporation of technology in teaching, can assist in students' engagement in collaborative note-taking activities.

While there was a relationship between video engagement and the amount of collaboration, interestingly, this effect did not extend to completeness. In other words, engagement with the videos made students collaborate more, but it did not increase the levels of completeness on their collaborative notes. Completeness could be seen as a measure of the quality of the students notes, as it reflects how well the students represented the contents of the lecture. This finding falls in line with other research that shows that it is not always the case that engagement with contents increases the quality of student collaboration (Sherer & Shea, 2011). The fact that increased video engagement does not impact note-taking completeness is an issue, because while increasing the amount of interaction students engage in is a good thing in and of itself, there is a hope that students' interaction with video lectures will lead to better collaboration in the form of more complete notes. This may mean that steps need to be taken by instructors to scaffold students into making more direct connections between the contents they are consuming and the notes they are producing.

The positive relationship found between the amount of collaboration students engage in and the completeness of their notes is unsurprising. This falls in line with prior studies that show that more collaboration leads to completeness on their collaborative notes (Costley & Fanguy, 2020; Gokhale & Machina, 2018; Kauffman et al., 2011). What is noticeable in the present study is the relatively moderate relationship between the two variables. Groups with higher amounts of collaboration should have relatively higher levels of collaborative completeness as has been shown in previous research. Because collaboration comes with its own set of costs of time and mental effort, it is possible that collaboration beyond a certain amount offers diminishing returns to product quality.

CONCLUSION

The present paper shows that students who interact more with videos online will engage in more online collaboration, though how complete their notes are might not increase. A video-watching lecture with shared display and distributed individual controls might enable study groups to find a fine balance between synchronicity, video interactivity, and discussions. These results have implications for MOOC pedagogical designers for the integration of collaborative learning practices in existing MOOC platforms. These results also provide practical guidance for instructors, practitioners, and researchers to further experimental validation of video watching and note-taking completeness.

The results of this study have implications for practitioners and pedagogical designers. The first is that online lectures must include tools that have an impact to engage learners, and there needs to be some degree of learner interaction with materials if instructors want students to interact well. Furthermore, online video lectures must have the functionality to allow students to interact. In this case, the Learning Management System (LMS) must allow students to easily pause, slow down, and review materials to maximize their engagement with the video lectures. This will allow a higher degree of interaction, which should, therefore, increase learner-to-learner interaction. Also, the integration of collaborative learning practices in existing online platforms needs to enable study groups to find a delicate balance between the level of collaboration, video interactivity, and note-taking. However, the lack of impact on the completeness implies that instructors need to provide some support transitioning learner engagement with online videos into a collaboration that results in more complete notes (Kahn et al., 2017). In the present study, no direct instruction was given on how to integrate their knowledge gleaned from the videos into complete sets of notes. It may be the case that short seminars on how to take notes in an online context might allow students to produce more complete learning artifacts.

The main limitation of this paper is the fact that video interaction was measured through a survey. This means that we were basing our levels of student interaction with the lectures on their perceptions of their behavior. In this case, clickstream data from the LMS would be a more accurate form of measure, or perhaps a construct combining clickstream data and student perceptions. Unfortunately, the current rules of the institution where the study was held do not allow the collection of student clickstream data. Future research could focus on two main areas. The first is obtaining more objective measures of student interactions with the videos. The second is broadening this research to look at how interaction with video lectures affects other types of collaboration. Furthermore, the present study focused on note-taking, and it seems likely that this particular type of collaboration will be affected differently than other types of collaboration, such as group projects or group discussions. With the importance of both video lectures and collaboration in e-learning today, gaining a broad understanding of how these two variables interact is of great value.

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