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Impact of Online Collaborative Video Annotation on STEM Students' Reflective Thinking and Academic Self-Discipline

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Abstract:- In recent years, technology-based education has been a trend for educationalists and educators. In line with this academic revolution, contemporary researches focus on how technology-aided methodologies and approaches affect students' academic achievement. For this reason, this study examined how online collaborative video annotation (OCVA) affects students' reflective thinking and academic self-discipline. With the result that online collaborative video annotation does not significantly affect reflective thinking and academic self-discipline among STEM students in General Chemistry 1. However, understanding as a component of reflective thinking was significantly affected by the use of OCVA. Although reflective thinking was associated with STEM students' academic self-discipline, it did not predict the latter.

Keywords:- *Video Annotation, Reflective Thinking, Academic Self-Discipline.*

I. INTRODUCTION

The purpose of this study was to test the extrapolations of a teaching approach that explains the impact of a Web 2.0 technology such as video annotation to Science, Technology, Engineering and Mathematics (STEM) students' reflective thinking and academic self-discipline. The study also focused on the relationship of reflective thinking as a predictor construct of academic self-discipline. The conceptual foundation for this teaching approach is a synthesis of existing learning theories, learning models and teaching methodologies.

This study determined the impact of online collaborative video annotation on STEM students' reflective thinking and academic self-discipline.

Specifically, this study sought to answer the following questions:

- Do students exposed to OCVA have higher reflective thinking than those students exposed to COVL?
- Do students exposed to OCVA have higher academic self-discipline than those students exposed to COVL?
- Is reflective thinking a positive predictor of academic self-discipline in video-based lessons in Science?

A. Video-Based Lessons in the 21st Century Classroom Dynamics

Video as a medium continues to have an on-going impact on higher education and on the role of the student. It also challenges the (traditional) role of the lecturer and the format of delivering course content via a lecture (Woolfitt, 2015). With this academic revolution, studies have been continuously conducted to assess effectiveness of video-based lessons (VBL). Specifically, multiple studies also have shown that video presentation can be a highly effective educational tool (Means et al., 2010; Schmid et al., 2014; Allen & Smith 2012; Kay, 2012; Lloyd & Robertson, 2012; Rackaway, 2012; Cigas 2013; Stockwell et al., 2015).

To effectively incorporate video presentations in the classroom of any courses, Brame (2016) set important guidelines to maximize student attention. She stated that educational videos presented should be around four (4) to six (6) minutes to effectively show a significant and positive connotation in terms of attention span (Guo et al., 2014; Brame, 2016; Risko et al., 2012). Particularly in science education context, videos are used to show simulations, laboratory phenomena and processes (Lenn Gia, 2015). Hence, to effectively use the video as lecture supplement in science courses, it has to be short to ensure student attention and it also gives emphasis to necessary scientific details as shorter videos are considered to be self-directed (Westhuizen, 2015).

B. Researches on Video Annotation influencing Reflective Thinking

In the current trend of VBL, educators use videos to draw attention from students (motivation) or drawing generalizations (synthesis) after the lesson. However, the use of videos to whatever part of the lesson alone does not signify effective learning (Yousef, Chatti, & Schroeder, 2014). With this endeavor, video technology offers a considerable potential for improving the quality of education and stimulating interest and involvement in academic excellence. Subsequently, with the presence of video technology materials, educators would be effective facilitators of learning in the 21st- century classroom (Abragan & Hambre, 2017). Thus, advancements in video-based instruction is continuously emerging in accordance to student reflection and assessment. One of the most valuable advancements in video-based instruction is the development of video annotation tools. In addition, a bigger picture is how video annotation tools can affect students' achievement in quizzes, homework and performance tasks through reflection to what they have seen in videos provided by the teacher. Whereas, preliminary findings reveal a significant positive relationship between annotating videos and examination results (Pardo et al., 2015). Video annotation also offer the potential to support both reflection and analysis of one's own learning (Van der Westhuizen & Golightly, 2015).

C. Academic Self-Discipline and Video-Based Learning

Video-based learning (VBL) is now recognized by Technology-Enhanced Learning (TEL) researchers as a powerful learning resource in online teaching activities (Yousef et al., 2014). Video technology is seemingly defining the importance of visuals for most of the learners nowadays. It is an obvious thing to observe that technology is tantamount to time. Video technology also encourages student interaction through social and multimedia platforms. Internet and Web-based technologies provide various mechanisms for supporting dialogue related to both informal and formal learning situations (Dabbagh, 2007). In 2005, Dabbagh and Bannan-Ritland reiterated that web-based group forum could actually hold discussion boards where formal and informal discussions could happen as well as exchanging of ideas in a specific content of discourse. This type of exchange and discourse develop a learner's sense of belonging in a community. As time flies by, so as technologists develop a vast resource of devices and applications that ease life in any aspect. In this study, the theoretical framework was based on Dale's Cone of Experience in 1969 (see Figure 1). Corroborating this model from Dale, is the conjunction of Social Constructivism and Collaborative Learning as a learning methodology. The efficiency of the VBL design depends on the need for it to be applied and injected in a lesson, plus how engaging the video is. Some researchers reported that students find instructional video attractive and taking them to higher degrees of satisfaction (Kearney & Treagust as cited in Vural, 2013).

Yousef et al. (2014) stated that according to Dale's cone, the most effective methods stand at the bottom. These methods involve direct experience, practical and hands-on workshops, which compel learners to better remember their activities. Interactive videos belong to this category as they enable learners to interact with the video materials through annotations, discussions, and assessments. This shows how essential the impact of video annotations would be to support retention and learning in the side of students.

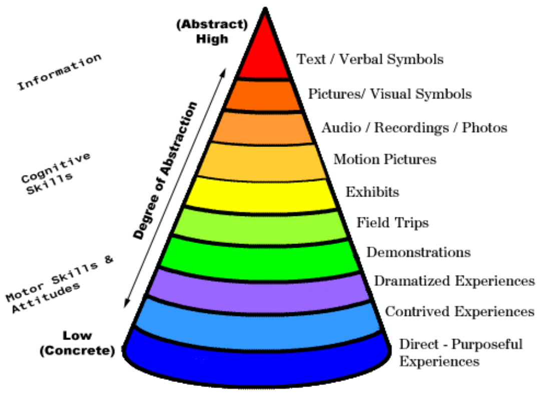

Fig 1:- Edgar Dale's Cone of Experience. From https://teachernoella.weebly.com/dales-cone-of-experience.html

II. METHOD

A. The Sample

Random Sampling used by the teacher-researcher from the Senior High School Department of a University in Manila. STEM students initially were divided into three (3) sub strands, STEM Science sections, STEM Technology sections, and STEM Engineering Sections. The teacher-researcher handled General Chemistry 1 course in three (3) STEM Engineering sections. All of these sections do have an equal number of students per class. To determine which would be the experimental and control groups for this study, the teacher-researcher used the fishbowl method.

B. Data Sources

Participants completed a series of questionnaires over a three-month period in their General Chemistry 1 class. The first questionnaire is reflective thinking questionnaire. The Reflective Thinking Scale has been developed by Leung et al., on December 2000, published in Assessment and Evaluation in Higher Education. It is a 16-item 5-point Likert Scale. The scale ranges from 5 (Definitely Agree); 4 (Agree with reservation); 3 (only to be used if a definite answer is not possible); 2 (Disagree with reservation); to 1 (Definitely disagree). The instrument has four (4) subscales which are Habitual Action, Understanding, Reflection, and Critical Reflection. The lowest possible score which could be obtained from each subscale is 4 and the highest possible score is 20. The reliability of the scales in this instrument is also considered as the values obtained all reach an acceptable level. Thus, making the instrument reliable.

The second questionnaire is academic self-discipline scale. The Academic Self -discipline Questionnaire has been developed by Faith Sal of the University of Leicester in 2018. It is a 58 item Likert scale ranging from 1 as Never, 2 as Rarely, 3 as Sometimes, 4 as Usually, and 5 as

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Always. The initial Cronbach's Alpha for the 58-item questionnaire was 0.933. After removing 13 items, the Cronbach's Alpha significantly increased to 0.95. A recent update was done by the developer of the instrument to trim down the items into 18 without compromising the reliability of the whole instrument. Given these points, the newly published reliability coefficient of Academic Self-Discipline Questionnaire is $\alpha = 0.90$.

To sum up, these questionnaires were found statistically reliable and valid regardless of all the limitations. Permission from developers of both questionnaires was obtained and fortunately, the consents were received through email. . The data gathered from LMS, personal journal, class observations, transcribed audio recordings and field notes were used to propose thematically organized qualitative data and eventually analyzed using qualitative data analysis and synthesis.

C. Procedure

Parental consent forms were sent home with students at the beginning of the second semester. The student-participants with parental consent completed their assent form. Afterwards, pre-test of both the reflective thinking and academic self-discipline questionnaires were administered to assess initial comparability of the students exposed to the proposed intervention – online collaborative video annotation (OCVA) and students exposed to the conventional video-based lesson (COVL). During the course of the second semester, the OCVA group (experimental group) was exposed to a Web 2.0 technology, namely VideoAnt which is a public domain video annotation software where students in a group could upload educational videos aligned with the criteria for video selection set by the teacher-researcher himself (see Table 1). Meanwhile, the COVL group (control group) use the same learning video inside the classroom for group dynamics, small group discussions and recitation purposes. Simultaneously during the course of intervention implementation, qualitative data were also obtained through classroom observation by the Science Coordinator of the University using the Classroom Observation Checklist formulated by University of Nebraska-Lincoln Graduate School, activities done in the University learning management system (LMS), videotaped lessons and researcher's journal. After six (6) consecutive lessons or learning cycles (see table 2), the teacher-researcher administered the post-test of the abovementioned questionnaires to assess the impact of OCVA to STEM students taking General Chemistry 1 course. The post-tests of both questionnaires were completed in March. Data analysis was completed in the month of April.

ELEMENTS TO CONSIDER	CRITERIA	LEARNER ANNOTATION IMPLICATIONS	EXAMPLE
Cognitive Load	*Signalling and Segmentation*	Reduces extraneous load, direct focus and connectivity among sub-topics	• Short videos (4-6 minutes) • Appropriate pacing of topics discussed for Grade 11 students.
	Connection of Auditory and Visual Channels to Classroom Context	Manages intrinsic load; enhances Germane load	• Complex backgrounds eliminated (music, visual crowd) • Purpose of the video was made explicit before eliciting facts.
Student Engagement	*Language Usage*	Creates a sense of social partnership between student and instructor, prompting the student to try harder to make sense of the lesson	• First person pronoun reference. • Narrator (if applicable) clearly states and explains scientific terminology. • Speaking rates in the 185–254 words per minute range
	Course Relevance	Promotes knowledge retrieval and sense of collaboration amongst learners.	• Explanatory text to situate video in course • Teacher stimulates learners to watch the video by asking real-life applications of how the phenomena to be explicated by the video relate to their lives and the course itself.
Active Learning	*Methodology*	Videos should be part of the enrichment portion of instruction.	• Videos to be presented show current events, relevance to Philippine context and student to society connectivity.
	Art of Questioning	May increase germane cognitive load, reduce extraneous cognitive load, and improve student self-assessment.	• Follow the sequence of basic learning domains (Cognitive, Affective and Psychomotor) • Questions that may be related to learner behaviour (academic self-discipline)
	Assessment	May increase student engagement, long-term knowledge retention, learning reflection and academic self-discipline.	• Intermittent questions to answer and to ponder per video segment. • Involve student engagement through sharing related thoughts and ideas.

Table 1:- Criteria for Video Selection

Note: Adapted from *Effective Educational Videos: Principles and Guidelines for Maximizing Student Learning from Video Content*, by Cynthia Brame, retrieved from https://www.ncbi.nlm.nih.gov/pubmed/27789532. Copyright 2016 by CBE – Life Sciences Education

Topic	Online Collaborative Video Annotation	Conventional Video-based Learning
	Cycle 1	
Dalton's Atomic Theory	Introduction: Communicating Learning Objectives	Introduction: Communicating Learning Objectives
	Motivation: Question and Answer	Motivation: Question and Answer
	Discussion: Lecture using powerpoint presentation	Discussion: Lecture using powerpoint presentation
	Wrap-up: Lesson Synthesis	Wrap-up: Lesson Synthesis
	Evaluation: Scientific Reflection using VideoAnt	Evaluation: Scientific Reflection using LMS
	Cycle 2	
Law of Multiple Proportions	Introduction: Communicating Learning Objectives	Introduction: Communicating Learning Objectives
	Motivation: Laboratory Activity	Motivation: Laboratory Activity
	Discussion: Lecture using powerpoint presentation	Discussion: Lecture using powerpoint presentation
	Wrap-up: Post-laboratory discussion	Wrap-up: Post-laboratory discussion
	Evaluation: Scientific Reflection using VideoAnt	Evaluation: Scientific Reflection using LMS
	Cycle 3	
Percent Composition by Mass	Communicating Learning Objectives	Introduction: Communicating Learning Objectives
	Motivation: Picture Analysis	Motivation: Picture Analysis
	Discussion: Lecture using powerpoint presentation	Discussion: Lecture using powerpoint presentation
	Wrap-up: Boardwork (Problem Solving)	Wrap-up: Boardwork (Problem Solving)

	Evaluation: Scientific Reflection using VideoAnt followed by an objective type of quiz	Evaluation: Scientific Reflection as lesson synthesis
Cycle 4		
Types of Chemical Equations and Reactions 1	Communicating Learning Objectives	Introduction: Communicating Learning Objectives
	Motivation: Virtual Laboratory (Balancing of Chemical Equations)	Motivation: Virtual Laboratory (Balancing of Chemical Equations)
	Discussion: Lecture using powerpoint presentation	Discussion: Lecture using powerpoint presentation
	Wrap-up: Video Annotation using VideoAnt	Wrap-up: Classroom Video Presentation and Synthesis
	Evaluation: Seatwork (formative assessment)	Evaluation: Seatwork (formative assessment)
Cycle 5		
Types of Chemical Equations and Reactions 2	Communicating Learning Objectives	Introduction: Communicating Learning Objectives
	Motivation/Instruction: Laboratory Activity - Indicators of Chemical Change	Motivation/Instruction: Laboratory Activity - Indicators of Chemical Change
	Wrap-up: Video Annotation using VideoAnt	Wrap-up: Classroom Video Presentation and Synthesis
	Evaluation: Laboratory Report	Evaluation: Laboratory Report
Cycle 6		
Mass Relationships in Chemical Reactions	Communicating Learning Objectives	Introduction: Communicating Learning Objectives
	Motivation: : Classroom Video Presentation/ Video Annotation comes after	Motivation: Classroom Video Presentation
	Discussion: Lecture using powerpoint presentation	Discussion: Lecture using powerpoint presentation
	Wrap-up: Synthesis/ open-inquiry	Wrap-up: Synthesis/ open-inquiry
	Evaluation: Seatwork (formative assessment)	Evaluation: : Seatwork (formative assessment)

Table 2:- Outline of Activities

III. RESULTS AND DISCUSSION

A. *Initial Comparability in Reflective Thinking and Academic Self-Discipline*

Table 3 shows that there was no significant difference in the mean pre-test scores in the reflective thinking questionnaire of OCVA (*M = 3.78, SD = 0.35*) and COVL (*M = 3.85, SD = 0.37*); t (*96*) = *-1.05*, p = *.296*. These results suggest that OCVA and COVL students' reflective thinking in General Chemistry 1 course were comparable prior to the intervention.

Group	Mean	Standard Deviation	t	df	Sig. 2-tailed
OCVA	3.78	0.35	-1.05	96	.296
COVL	3.85	0.37			

**p <.05*

Table 3:- OCVA and COVL Mean Pre-test Results in Reflective Thinking Scale

Subsequently, Table 4 shows that there was no significant difference in the mean pre-test scores in the academic self-discipline scale of OCVA (*M = 3.08, SD = 0.42*) and COVL (*M = 3.11, SD = 0.37*); t (*96*) = *.47*, p = *.64*. These results suggest that OCVA and COVL students' academic self-discipline in General Chemistry 1 course were comparable prior to the intervention.

Group	Mean	Standard Deviation	t	df	Sig. 2-tailed
OCVA	3.08	0.42	0.47	96	.64
COVL	3.11	0.37			

**p<.05*

Table 4:- OCVA and COVL Mean Pre-test Results in Academic Self-Discipline Scale

B. *Effect of Online Collaborative Video Annotation (OCVA) on STEM Students' Reflective Thinking*

A one-tailed independent-samples t-test was conducted to compare the mean posttest scores of students exposed to OCVA and COVL in reflective thinking. Table 5 shows that there was no significant difference in the posttest scores in the reflective thinking scale of OCVA (*M* = 4.14, *SD* = 0.28) and COVL (*M* = 4.05, *SD* = 0.42); *t* (96) = 1.19, *p* =.12. The mentioned results show that there is not enough evidence that OCVA is statistically different from COVL.

Group	Mean	Standard Deviation	t	df	Sig. 1-tailed
OCVA	4.14	0.28	1.19	96	.12
COVL	4.05	0.42			

**p <.05*

Table 5:- OCVA and COVL Mean Posttest Results in Reflective Thinking Scale

The results may be caused by the fact that students are too accustomed to attend to their own questions about the videos presented. However, due to some unfamiliar scientific terms used in the video, students find it difficult to retrieve relevant experiences to support reflection. This is in line with Rodgers' (2002) postulate that if students would be able to retrieve relevant experiences from the past, continuity of learning would be evident. In addition to this, Turner et al. (n.d) added that this continuity of learning is essential to generalization and application of learning from one situation to another.

With the inferential data provided, it could be concluded that the four (4) components of reflective thinking collectively does not affect students' reflective thinking in general chemistry 1 course. Thus, the teacher-researcher did post hoc analysis to each components to check on possible themes that may arise.

➢ *Habitual Action*

The first component is habitual action. Habitual action was defined by the developers of the instrument as frequent use of acquired knowledge that eventually becomes an activity done without or with little consciousness. Table 6 presents the comparison of mean posttest scores of students exposed to OCVA and COVL in habitual action (HA). The table also shows that there was no significant difference in the posttest scores in the habitual action component of reflective thinking of OCVA (*M* = 3.67, *SD* = 0.59*)* and COVL (*M* = 3.54, *SD* = 0.49*); t* (96*)* = -1.204, *p* = .116. To further understand what transpired on this component of reflective thinking, the researcher used Mann-Whitney U Test. Having the initial assumption from one-tailed t-test was not met, the results on this non-parametric test would supplement further understanding of two groups – high performing and low performing students, on both research groups. Specifically, this test would identify if there were significant differences on posttest scores of the 10 highest scores and 10 lowest scores on both OCVA and COVL groups. The non-parametric tests result in 10 highest scorers on both groups is non-significant. Meanwhile, the result in the 10 lowest scores is significant with OCVA getting the higher mean than the other. The non-parametric tests suggest that although the results on this reflective thinking is non-significant, it could be inferred that the below average students in OCVA group have better habitual action than of below average students in COVL. However, note that two samples were not statistically matched.

➢ *Understanding*

The second component of reflective thinking is understanding, Leung et al. (2000) defined understanding as comprehension of concepts without relating it to personal and practical situations. Table 6 presents the data obtained from using one-tailed t test to understanding component of reflective thinking. The mean posttest scores of OCVA (*M* = 4.55, *SD* = 0.64) and COVL (*M* = 4.37, *SD* = 0.36); *t* (96) = 1.690, *p* = .047 show that there was significant difference. Mann-Whitney U Test was also used to determine possible significant differences in 10 highest scores and 10 lowest scores in understanding component of reflective thinking. The non-parametric test infer that there was no significant difference with the 10 highest posttest scores of OCVA and COVL groups. Conversely, the results in 10 lowest posttest scores is significant with OCVA group having the higher mean. This test suppose that the low performing students from the OCVA have better understanding of topics discussed than of low performing students from COVL.

➢ *Reflection*

The third component of reflective thinking is reflection. Reflection happens when intellectual and affective activities of an individual engages the retrieval of relevant past experiences to acquire new set of skills or knowledge (Dewey, 1933; Boud et al., 1985; Boyd & Fales, 1983). Table 6 shows that the mean posttest scores of students exposed to OCVA (*M* = 4.18, *SD* = 0.47) and COVL (*M* = 4.15, *SD* = 0.50); *t* (96) = -.313, *p* = .378. The results suggest that OCVA has statistically no difference with COVL. The same results apply to Mann-Whitney U test done on this component of reflective thinking. Both 10 highest posttest cores and 10 lowest posttest scores suggest that there were no significant differences in terms of reflection.

➢ *Critical Reflection*

The last reflective thinking component examined by the researcher is the critical reflection. The developers of this tool defined critical reflection differently from reflection component. As critical reflection is defined as a deeper level of reflection. To put this into context, Dewey (1933) argued that if a person is not critically reflecting, that person tends to be hasty on giving conclusions without considering other possibilities and circumstances. Table 6 presents that there was no significant difference on mean posttest scores of OCVA (*M* = 4.14, *SD* = 0.60) and COVL (*M* = 4.14, *SD* = 0.55); *t* (96) = .000, *p* = 1.00. The same results apply to Mann-Whitney U test done on this component of reflective thinking. Both 10 highest posttest scores and 10 lowest posttest scores suggest that there were no significant differences in terms of critical reflection.

Reflective Thinking Component	**Group**	**Mean**	**Standard Deviation**	**t**	**df**	**Sig. 1-tailed**
Habitual Action (HA)	OCVA	3.67	0.59	-1.204	96	0.116
	COVL	3.54	0.49			
Understanding	OCVA	4.55	0.64	1.69	96	0.047
	COVL	4.37	0.36			
Reflection	OCVA	4.18	0.47	-0.313	96	0.378
	COVL	4.15	0.5			
Critical Reflection	OCVA	4.14	0.6	0	96	1
	COVL	4.14	0.55			

Table 6:- OCVA and COVL Mean Posttest Results in Reflective Thinking Components

C. *Effect of Online Collaborative Video Annotation (OCVA) on STEM Students' Academic Self-Discipline*

A one-tailed independent-samples t-test was conducted to compare the mean posttest scores of students exposed to OCVA and COVL in academic self-discipline. Table 7 shows that there was no significant difference in the posttest scores in the academic self-discipline scale of OCVA (*M* =3.33, *SD* =0.30) and COVL (*M* =3.28, *SD* =0.43); *t* (96) = 0.64, *p* =.26. The results show that there is not enough evidence that OCVA is statistically different from COVL.

Group	Mean	Standard Deviation	t	df	Sig. 1-tailed
OCVA	3.33	0.3	0.64	96	.26
COVL	3.28	0.43			

**p<.05*

Table 7:- OCVA and COVL Mean Posttest Results in Academic Self-Discipline Scale

Academic self-discipline is a non-cognitive construct which could vary in learning disciplines. Involving the use of Web 2.0 technologies make it more multifaceted to understand academic self-discipline. Supplementing this inference, Gong et al. (2009) have established that self-discipline's impact on students using computers is complex, and appears to influence knowledge and performance of students in school. The teacher-researcher also have observed that students persuaded by some elements of the videos presented. Students do have personal considerations to catch their attention to watch the video outside the context of external considerations. The commonalities in student interview are as follow:

- It should be animated
- Has subtitle
- Trivial/ includes random facts
- Short-spanned video

Considerations a, b and d are all included in the criteria of video selection set by the researcher himself. However, letter c was an emerging theme noted from this study. It could be inferred that some students from the experimental group are intrinsically motivated to learn more on their own. This finding is concomitant to Choi & Johnson's study where video-based instruction can effectively be used to motivate learners by tracing their attention. As it was found out that OCVA made them curious not just about the topic discussed, it also made them responsible to their own learning. This supports the claim of D'Silva (2010) that students' discipline after being exposed to OCVA made them process information efficiently and ready to acquire newly acquired information for possible connivance.

D. Reflective Thinking as Predictor of Academic Self-Discipline

The posttest total scores in the academic self-discipline scale were subjected to simple linear regression with reflective thinking as the predictor variable. Table 8 presents the results.

The model summary table (Table 8.1) shows the simple correlation coefficient between reflective thinking and academic self-discipline is *R*= 0.210. The adjusted value is 0.034, which means that only 3.4% of the variation in the academic self-discipline posttest scores can be explained by reflective thinking skills. Results of the analysis of variance (Table 8.2) indicate that the regression model has weak uphill (positive) relationship and reflective thinking did contribute to predict academic self-discipline but is statistically non-significant, *F*(1, 96) = 4.442, *p* =.38. Reflective thinking is not a significant predictor of academic self-discipline. However, the Pearson correlation (Table 8.4) coefficient is significant, *r*(98) = .019, *p* = .210.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.210	0.044	0.034	0.36

Table 8.1:- *Model Summary*

Model		Sum of Squares	df	Mean Square	F	P
1	Regression	.586	1	.586	4.442	.38*
	Residual	12.662	96	.132		
	Total	13.248	97			

**p<.05*

Table 8.2:- *ANOVA*

Model		Unstandardized Coefficients		Standardized Coefficients	t	p
		B	Std. Error	Beta		
1	(Constant)	2.41	0.425		5.675	.0001*
	Reflective Thinking	0.22	0.104	0.21	2.108	0.038

**p<.05*

Table 8.3:- *Coefficients*

		Academic Self-Discipline	Reflective Thinking
Pearson Correlation	ASD	1	.21
Sig. 1-tailed	ASD	-	.019
N	ASD	98	98

**p< .05*

Table 8.4:- *Pearson Correlation*

Table 8:- *Linear Regression Results of Posttests in Reflective Thinking and Academic Self-Discipline*

E. General Discussion

A major contribution of this study is the qualitative data obtained from existing pertinent literatures, classroom observations and student annotations and it interviews. These data were paralleled to the statistical data obtained to provide a rich-text synthesis of what transpired during the learning cycles.

Firstly, the statistical data obtained shows that there was no significant difference with the mean post-test scores of OCVA and COVL groups in reflective thinking. Consequently, with this result, the researcher assessed the effect of OCVA to reflective thinking components – habitual action, understanding, reflection and critical reflection. The results obtained from habitual action imply that it is not enough that students would be able to retrieve relevant experiences. Students have to actualize their newly acquired knowledge from learning videos to promote collaboration and continuity of learning. In which case, students would be able to develop a way questioning to unfamiliar situations especially in the field of sciences (Gibbs, 1988; Turner, 2017). It is imperative to consider the longevity of habitual action's effect to students' reflective thinking. With this, the teacher-researcher recommends to give emphasis on lesson activities that will incorporate retention which is vital to student's familiarization of scientific phenomena. For example, if general chemistry students would be able to familiarize themselves on the characteristics of acids, they will subconsciously develop the trait of using their sense of smell to determine acids or even familiar themselves with the use of materials necessary for determining acids.

Secondly, the result for the understanding component of reflective thinking is different. It could be inferred that online collaborative video annotation promotes better concept understanding among students. The results may be affected by the fact that videos for annotation follow signalling and segmentation criterion from the criteria of video selection. This particular criterion is in line with the multimedia and segmentation principles of Mayer (2016). The concepts were presented in visually manner and not mere words or bookish definitions. To add on this, segmentation of video contributed also to this supposition. The science education expert observed that student confusions associated with jargons were addressed by the teacher-researcher through intermittent confirmation inquiries. In fact, student interviews have shown that students better understood these scientific jargons through use of animations and subtitles. Thus, it is recommended to give emphasis on terminology to be used in science-based lesson. Giving the dictionary-based definitions are not enough. 21st century students tend to find meaning on how their senses perceive a phenomena. Online video annotation was indeed an innovative tool to promote students' better understanding. It is also recommended that, science teachers should not limit students' sources of defining concepts. However, it is imperative that students should be able to decipher on what sources should be used. The use of signaling and segmentation proposed by Brame (2016) and the multimedia principles of Mayer (2011) would be of great help to achieve better concept understanding.

Thirdly, the results obtained from the third reflective thinking component may be affected by the fact that students on both groups do have substantial scientific reflections on videos presented. The only difference may be the platform where scientific reflections are made. Most especially for the first two (2) cycles where both OCVA and COVL groups were in the preliminary stages of doing their scientific reflections online and deviating from the journal type, paper-written scientific reflections. These stages are crucial since students tend to get accustomed to available online resources they could use to enrich their scientific reflection. In this case, the researcher himself have realized that students of the 21st century are heavily dependent on resources online. To supplement this claim, the science education expert also have observed that although OCVA integrates real-world applications, some points may or may not be highlighted as these points may be crucial to student's reflection towards the topic. Given the fact also that students to have different learning pacing. Academically performing students may somewhat have an idea of the keywords presented in the video, and the average students may not have. Thus, students would find it hard to acquire new set of skills if they would not be able to develop information processing. More importantly it could hinder them on acquiring motor skills and positive attitude towards the course. With this, it is recommended to develop and formulate mini-activities prior to the video annotation to re-assess students' grasp of the topic – as synthesized in the learning video presented. The results in this reflective thinking component corroborates reflection implication that students tend to categorize their relevant experiences to what is necessary for the lesson and use it for future needs (Boud as cited in Prilla et al., 2015).

Lastly, the results in critical reflection component shows that OCVA as a teaching approach do not significantly affect students' critical reflection in chemistry. The teacher-researcher himself have observed through videotaped material that students answer the teacher-formulated questions based on what they know prior to the learning videos presented. Some students were able to cite relevant scientific phenomena. For example, for learning cycle 4, the teacher asked the students if combining milk and vinegar produces a new substance – a prerequisite to chemical reaction. Well in fact, combining milk and vinegar does not produce a new substance. The protein produced is a mixture which is clearly not a pure substance. In which, mixture is not considered to be a pure substance. Out of all the four components of reflective thinking, critical reflection is considered to be the most difficult to gauge since it comes with longevity of intervention assessment. For students to be able to come up with critically analyzed conclusions, time plays an important role. In the case of learning cycle 4, majority of the groups have concluded that mixture of milk and vinegar produces new substance. The same answers were observed when the teacher-researcher checked their laboratory reports. Thus, the same answers have reflected to their video annotations.

Since the video annotation serve as synthesis, it gave an empirical analysis to the researcher that students' experiences and knowledge about mixture were not sufficient enough to formulate critical reflection. The study of Leijen et al. (2009) have shown that even though teacher-formulated questions are deemed effective to assess learning, it might not be sufficient enough for students to do scrutinize all possibilities on the conceptual questions and on a more general level of practical experience. The observation of the teacher is also parallel to the observation of the science education expert. The expert have noticed that addressing conceptual and practical misconceptions in science would lead to better understanding and critical analysis. Hence, it is recommended to address student misconceptions through intermittent guide questions in the videos presented. More efficiently, monitor students' practical misconceptions to avoid further knowledge gaps.

As a final point to fully scrutinize the linear regression results obtained, the teacher-researcher opted to use individual reflective thinking component results as predictor of academic self-discipline. Each component was subjected to simple linear regression with reflective thinking components as predictor variables and academic self-discipline as the outcome variable. Table 9 presents the linear regression results between reflective thinking components and academic self-discipline. The table shows that there is weak correlation between habitual action and academic self-discipline is *r(98) = .079, p = .219*. The results suggest that habitual action did contribute to predict academic self-discipline, but is statistically non-significant. For the second component, understanding, there is also weak correlation to academic self-discipline *r(98) = .169, p = .048*. The results for the second component suggest that understanding did contribute to academic self-discipline and is statistically non-significant. The third component of reflective thinking is reflection. The results of linear regression implies that there is also a weak correlation between reflection and academic self-discipline *r(98) = .178, p = .040*. The results propose that reflection did contribute to academic self-discipline and is statistically non-significant. Lastly, the fourth component of reflective thinking is critical thinking. The results show that there is a weak correlation between critical reflection and academic self-discipline *r(98) = .145, p = .077*. Thus, critical reflection did contribute to academic self-discipline but is statistically non-significant.

		Habitual Action	Understanding	Reflection	Critical Reflection
Pearson Correlation	Academic Self-Discipline	.079	.169	.178	.145
Sig. 1-tailed	Academic Self-Discipline	.219	.048	.040	.077
N	Academic Self-Discipline	98	98	98	98

**p<.05*

Table 9:- Pearson Correlation Results of Reflective Thinking Components to Academic Self- Discipline

The tests for each of the components of reflective thinking that there were specific components were academic self-discipline of STEM students could be predicted – particularly, understanding and reflection. However, only 3.4% of the variation in academic self-discipline posttest scores could be explained by reflective thinking, and is statistically non-significant *p* = .38.

IV. CONCLUSIONS

In conclusions, online collaborative video annotation (OCVA) did not affect STEM students' reflective thinking collectively. However, OCVA was effective on developing STEM students' understanding – a reflective thinking component. Furthermore, OCVA was considered to be effective on developing the habitual action and understanding of low-performing STEM students in general chemistry 1 course.

To add on this, Online collaborative video annotation did not affect the average STEM students' academic self-discipline. However, OCVA did affect high-performing and low-performing students' academic self-discipline in a positive manner.

Lastly, reflective thinking as a whole did not predict STEM students' academic self-discipline. To add on this, reflective thinking components: habitual action, understanding, reflection and critical reflection contributed to academic self-discipline.

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APPENDIX A. REFLECTIVE THINKING QUESTIONNAIRE

Name: ______________________________________ ID #:_________________
GRADE & SECTION: __________________________

DIRECTION: Please fill in the appropriate box of check mark to indicate your level of agreement with statements about your actions and thinking in this course.						
	5—definitely agree 4—agree with reservation 3—only to be used if a definite answer is not possible 2—disagree with reservation 1—definitely disagree	**1**	**2**	**3**	**4**	**5**
1	When I am working on some activities, I can do them without thinking about what I am doing.					
2	This course requires us to understand concepts taught by the lecturer.					
3	I sometimes question the way others do something and try to think of a better way.					

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4	As a result of this course I have changed the way I look at myself.					
5	In this course we do things so many times that I started doing them without thinking about it.					
6	To pass this course you need to understand the content.					
7	I like to think over what I have been doing and consider alternative ways of doing it.					
8	This course has challenged some of my firmly held ideas.					
9	As long as I can remember handout material for examinations, I do not have to think too much.					
10	I need to understand the material taught by the teacher in order to perform practical tasks.					
11	I often re • flect on my actions to see whether I could have improved on what I did.					
12	As a result of this course I have changed my normal way of doing things.					
13	If I follow what the lecturer says, I do not have to think too much on this course.					
14	In this course you have to continually think about the material you are being taught.					
15	I often re-appraise my experience so I can learn from it and improve for my next performance.					
16	During this course I discovered faults in what I had previously believed to be right.					

Table 10

APPENDIX B. ACADEMIC SELF-DISCIPLINE QUESTIONNAIRE

Name: ____ **ID #:**___________________
GRADE & SECTION: ___________________________

Direction: Put a check mark on the box that corresponds your answer.

1= Never, 2=Rarely, 3=Sometimes, 4=Usually, 5= Always	1	2	3	4	5
1. I wake up the same time everyday					
2. I repeat my modules after class I make a preparation before class.					
3. I do not allow my choices to be dictated by impulses of my feelings					
4. I have my own study time table					
5. I use my study time wisely					
6. I study randomly *					
7. I imagine something else while I am in class *					
8. If I have planned to study, I can refuse to hang around with my best friend *					
9. I do not use my Facebook account while studying even though I desire it much					
10. I am cognitively ready before starting to study					
11. I organise my study place where there are not any distracters					
12. I remove everything that disturbs me					
13. I know what to study before start studying *					
14. I do not use Facebook while studying					
15. I keep myself away from distracting elements to study effectively					
16. I know how to study					
17. If I got higher mark, I give up studying *					
18. I sustain attentional focus despite distractions, boredom, or fatigue					

**Reverse score questions*

Table 11