



# American Journal of Multidisciplinary Research and Innovation (AJMRI)

ISSN: 2158-8155 (ONLINE), 2832-4854 (PRINT)

VOLUME 4 ISSUE 2 (2025)



PUBLISHED BY  
E-PALLI PUBLISHERS, DELAWARE, USA

## Utilization of Micro-lecture Videos in Teaching Selected Microbiology Laboratory Topics

Monica Joyce S. Sespeña\*

### Article Information

**Received:** January 08, 2025

**Accepted:** February 11, 2025

**Published:** March 17, 2025

### Keywords

*Blended-Learning, Culture Media Preparation, Gram Staining, Instructor-Made Micro-Lecture Videos, Supplementary Materials*

### ABSTRACT

The sudden shifting of classes to online class set-up is ineluctable in Philippine education today due to many events and adverse environmental conditions. Laboratory courses are most affected by the limited procedural videos that are explicitly developed and target the students of the current generation, particularly microbiology laboratory procedures. Hence, this study utilized developed instructor-made micro-lecture videos (IMMV) of selected microbiology laboratory topics (Culture Media Preparation and Gram Staining) as supplementary materials in a blended-learning asynchronous class set-up. A mixed method-explanatory sequential was used with 54 Medical Biology students through a validated pre-test, post-test, and survey. Through a paired t-test, the pre- and post-test scores of the experimental group revealed significant differences in their scores. Moreover, an independent t-test was used to analyze the post-test scores of the control and experimental groups, which revealed a significant difference in their performance. Students perceived that utilizing IMMV positively affects their academic performance in terms of control over the learning process, knowledge retention, and intrinsic motivation. As such, IMMVs are brief, concise, time-efficient procedures, effective guides for learning, provide sufficient learning, developed with encouraging and motivating content, captivate learners' attention and interest, create a significant learning impact for students, promote advanced learning efficiency, and provide convenience for student's learning. This suggests that learning microbiology laboratory topics through micro-lecture befits the needs and learning styles of the generation of learners today sufficiently and effectively.

### INTRODUCTION

A laboratory course offered at a Higher Education Institution (HEI) under the program BS Biology major in Medical Biology is Microbiology, which deals with living things that are naturally microscopic. It introduces abstract concepts and procedures about different microorganisms that must be explained comprehensively (Cowan, 2015). It also concerns with several diagnostic procedures which require specific equipment for a specific microorganism to identify, and the procedures must be done aseptically to ensure the accuracy of the results. Due to ineluctable events within the institution, environmental conditions, and public health issues occurring, sudden shift of learning modalities from face-to-face to online class setting are immediately implemented.

During a blended-learning class set-up (online asynchronous), laboratory courses such as microbiology introduce the topics in many options including, demonstration of laboratory procedures through virtual laboratory, pre-recorded laboratory demonstration of instructor at school (Andrews *et al.*, 2020), traditional discussion through online meeting, on-the-spot demonstration of laboratory procedures at school, and the most common is providing video lectures as learning resources to communicate the course content to students, improve laboratory functionality, foster academic integrity, and facilitate student success (Campbell *et al.*, 2020).

In a full face-to-face class set-up, demonstration of procedure meets limitation due to the availability and structure of the laboratory facilities, the arrangement of the laboratory equipment is in a narrow space, and some equipment are too small that students cannot appreciate its use during the demonstration. With these factors, it is observed when the instructor demonstrates, some students cannot sufficiently view the proper demonstration of the procedure due to massive gathering near the instructor, leaving others with no space to view the procedure. Therefore, incorporating modern teaching strategies is still applicable to the status of education today.

Herewith, an innovative teaching strategy must be incorporated in a blended-learning approach (online or face-to-face) to address the mentioned issues. These strategies can be further improved through interactive learning approach. It encourages the students to engage with the subject matter, whether online (Manap *et al.*, 2013) or face-to-face class setting. A relevant example is the Micro-lecture video, a modern teaching strategy utilized by the 21st century education. It is widely known as a short-recorded video lecture that covers one single topic which is commonly utilized as a supplementary material. There are plenty of video lectures on Youtube and other websites, but most have extensive duration, which commonly lead to student's perfunctory manner. Moreover, some require payment for a subscription to

<sup>1</sup> Palawan State University, Philippines

\* Corresponding author's e-mail: [mjsespeña@psu.palawan.edu.ph](mailto:mjsespeña@psu.palawan.edu.ph)

access the videos entirely and most micro-lecture videos used in the study are not instructor-made.

Thus, this study utilized developed instructor-made micro-lecture videos of the selected microbiology laboratory topics, the Culture Media Preparation and Gram Staining procedure which served as supplementary materials. These learning materials were utilized in a blended-learning class set-up and evaluate its effects on the students' academic performance. This study explicitly aimed to determine the pre- and post-test scores of the control and experimental groups and the significant differences in their post-test scores, determine the significant difference in the post-test scores of the experimental group, and evaluate the effects of utilizing instructor-made micro-lecture videos on the students' performance in terms of control over the learning process, knowledge retention, and intrinsic motivation.

## LITERATURE REVIEW

### Educational/Lecture Videos

Educational videos are useful and relevant to the current approach to education. They could be applied in all class set-ups (Online, Blended, or face-to-face), as presented by the previous studies. It is widely used in education to deliver lecture/conceptual and tutorial/procedural topics. Beheshti *et al.* (2018) described video-based learning as “powerful.” It meets the audio-visual learning style of students, promotes individual learning, and improves motivation and concentration levels. However, when educational videos are utilized as the sole learning material, it often offers extensive video-duration because, according to Lapitan *et al.* (2021) it discusses conceptual knowledge that requires extensive discussion. Studies suggest that an effective lecture video has a limited duration, as opposed to the lecture videos utilized by Lapitan *et al.* (2021) and Nabayra (2020). Longer videos must be divided into segments with interactive activities in between to maintain the attention and engagement of students. A shorter video helps students retain knowledge regarding the topics because they can easily find the concept in a shortened video focusing on one topic (Deng *et al.*, 2014; Guo *et al.*, 2014; Beheshti *et al.*, 2018).

Shortened or segmented video is similar to the concept of Micro-lecture videos, which several educators have utilized in teaching conceptual and procedural topics. As proposed by this study, procedural/tutorial micro-lecture videos of selected Microbiology laboratory topics will be utilized. Employing the principles of the educational videos will strengthen the quality of the study instrument as well as its goal of promoting active learning.

### Characteristics of Micro-lecture videos

Micro-lecture teaching is a new method acquired from modern online courses (Shuping *et al.*, 2019). It is commonly known as short-recorded audio or video

made on a single, compact, defined topic containing an introduction, main points, and conclusion (Zheng, 2022). It contains one main topic compressed into five (5) to eight (8) minutes or less than 10 minutes (Tianjiao, 2020; Zheng, 2022). Yang *et al.* (2016) stated, “Micro-lecture videos should be short, concise, simple, acceptable, and common, and could be introduced continuously.” It is intentionally created short for students to understand the concept briefly and master it quickly (Supriadi *et al.*, 2020).

All previous studies provided evidence that short, animated, instructor-narrated educational videos are engaging, motivating, and activate audio-visual learning, which helps retain concepts in long-term memory. Thus, it is a relevant teaching tool that must be applied and evaluated with biological concepts.

### Standard Design & Guidelines of Educational Micro-lecture videos

Educational micro-lecture videos have several standard designs to achieve effective instructional videos. The study of Mayer *et al.* (2020) and Chen *et al.* (2020) recommends to follow the Cognitive Theory of Multimedia Learning, which suggests that learning occurs through audio-visual learning (dual-coding) that can actively filter, selects, organizes, and incorporate the information obtained with prior knowledge. Thus, previous studies suggest to follow CTML guiding principles in developing lecture video design, which includes coherence, signaling, redundancy, spatial and temporal contiguity, segmenting, pre-training, modality, personalization, voice, and embodiment. Through these principles, the learning video could successfully support the limited resource of the cognitive load and remove extraneous materials which may distract students' learning. Additionally, Mayer *et al.* (2020) suggested other principles such as dynamic drawing, gaze guidance, generative activity, perspective, subtitle, and seductive details which are essential to make instructional learning video more effective.

The utilization of micro-lecture videos as a learning resource can be a passive teaching method. Thus, incorporation of the standard design suggested by the previous studies is an advantageous technique to achieve active learning. However, the provided standard designs were primarily applied in developing conceptual micro-lecture videos rather than tutorial/procedural topics. Although this study aims to provide instructor-made micro-lecture videos, the standard designs demonstrate homogenous objectives to the goal of this study. Therefore, the necessary designs and guidelines will be employed in the utilization of micro-lecture videos in teaching microbiology laboratory topics.

### Application of learning videos in biological concepts

In utilizing micro-lecture videos in a biology classroom, three essential elements must be considered such as student's cognitive load, engagement, and active learning

(Brame, 2016). Considering these essential elements in creating effective micro-lecture videos may address the internal and external factors of students that were identified as hindrances to good academic performance. Furthermore, Lestari *et al.* (2020) listed several internal factors, including a lack of motivation, no interest in studying microbiology material, a lack of readiness and preparation, a lack of student skill in searching for other learning resources, attitudes in learning, concentration, difficulty in understanding the materials, self-confidence, and study habits. These internal factors have complementary external factors. As mentioned by Lestari *et al.* (2020) & Mamman *et al.* (2018), students experience difficulties due to the use of textbooks alone as a learning resource or PowerPoint materials that are lengthy and have excessive contents which contain abundant and complex concepts and terms of biology (Hadiprayitno *et al.*, 2019; Fauzi *et al.*, 2021). Additionally, other external factors concern the teacher's quality (Mamman *et al.*, 2018) because some teachers were observed to have a lack of knowledge and skills regarding the concepts and procedures being taught. Lastly, the choice of traditional teaching methods and techniques applied in a classroom. These previous studies served as the structure of this study in the utilization of micro-lecture videos in teaching microbiology laboratory topics to support the student's essential elements in learning, which can significantly affect their academic performance in terms of control over the learning process, knowledge retention (Scholtenhuis *et al.*, 2020) and intrinsic motivation (Makransky *et al.*, 2016).

Application of Micro-lecture in Biology and Microbiology Observed in the study of Reidl *et al.* (2021), the students successfully demonstrated an improvement in academic performance through the use of modules, with short readings and supplementary materials, including brief videos, interactive quiz questions, and learning activities regarding common biological concepts, helped the students to learn common biological concepts. Similarly, Kareem (2018) presented that the students who learned biology with the utilization of multimedia demonstrated improvement in achieving the learning outcomes because it captured students' attention and interest in learning which positively improved their attitude towards learning biology compared to students under conventional teaching. Brame (2016) mentioned that in maximizing the utilization of videos in a biology classroom, three (3) essential elements must be considered, these are cognitive loads, student engagement, and active learning. Cognitive loads of learners affect students' working memory to accept, process and deliver the acquired knowledge to the long-term memory. As shown in the study of Thornton *et al.* (2017) utilized MOOC micro-lecture videos to engage students in learning Molecular biology. Results revealed that in learning molecular biology, students tend to be engaged and demonstrate higher cognitive load with lecture videos in which teachers are present narrating

the lesson. However, the study also suggested that micro-lecture only applies to some biological concepts since some concepts and procedures require detailed and extended discussion. Despite the limitation, this study will continue to investigate the application of micro-lecture in the field of Microbiology.

Of many branches of Biology, Microbiology is one of the essential and comprises broad concepts concerning microorganisms and their features. Microorganisms are ubiquitous and can only be seen through a microscope (Flemming & Wuertz, 2019). The study by Wang *et al.* (2019) utilized multimedia in teaching microbiology and evaluated its efficacy for students and teachers. The study described multimedia teaching as "vivid, intuitive, and interesting in learning." The vivid animation, audio, and video display of Microbiology conceptual and procedural topics (cellular structures and other processes in viewing microorganisms through staining) utilized in the study affected the interest and enthusiasm of students in learning. It also enhanced their ability to understand and memorize the concepts, similar in the study of Lacey *et al.* (2021).

Additionally, students preferred to learn and experience microbiology laboratory topics in online and in-person class set-ups (Brockman *et al.*, 2019). Online laboratory sessions effectively deliver theoretical concepts for students, which excites their visual learning style because it provides convenience in accessing the materials at their own pace (Joji *et al.*, 2022). Studies mentioned that the incorporation and utilization of multimedia tools, including PowerPoint, images, case studies, clinical cases, and videos, allow students to review and sharpen their learning. Hence, a micro-lecture video is a useful learning resource, particularly in blended-learning class set-ups, because students can rewatch, relearn, and practice the procedures they learned from the instructional videos (Brockman *et al.*, 2019). As suggested by Cheng (2015), micro-lecture should also be utilized in teaching practical or skill-oriented topics as a guide in learning and applying concepts in an actual setting, similar to the materials utilized by the study of Loughlin *et al.* (2021).

Considering the evidence of previous literature and studies regarding the utilization of micro-lecture video and its effect on students' performance. This study adopted the suggestions that would help address difficulties of students in learning biological concepts.

## MATERIALS AND METHODS

### Research Design

This study was carried out using a mixed method-explanatory sequential research design. For the quantitative research design, a pre-test was administered to the control and experimental group and both groups were subjected to a blended-learning class set-up which instructor-made micro-lecture videos were utilized. After utilization, a post-test was administered to evaluate the significant differences in the pre- and

post-test scores of the control and experimental groups. Moreover, an adopted and modified four-point Likert-scale survey was administered to the experimental groups to evaluate their agreement on the effects of the utilization of micro-lecture videos in their academic performance in terms of their control over the learning process, knowledge retention, and intrinsic motivation. For the qualitative research design, to further investigate students' perception on the effects of utilizing IMMVs, this study incorporated four (4) open-ended questions to each category on the adopted and modified survey questionnaire. These questions were used to provide support on the quantitative result of the survey and to further expound data on the phenomenological aspect.

### Respondents

The study obtained a total of fifty-four (54) students from the program BS Biology major in Medical Biology enrolled in the course Microbiology through voluntary sampling. Twenty-five (25) students were from Block one (1) and twenty-nine (29) students were from Block 3. Each group were randomly assigned as the experimental and control group, respectively.

### Research instruments

Both test and survey instruments were subjected to content validity with three (3) biology teachers from the College of Sciences who are knowledgeable about the topics. The result of the validation for test and survey summarized and analyzed through Aiken's V coefficient, adopted from the study of Ikhsanudin, & Subali (2018).

### Test Questionnaire

A forty-five (45)-item test questionnaire for the pre-and post-test were developed utilized in the study. With the use of Aiken's V coefficient, each item of the pre and post-test revealed a rating, ranges from 0.89 to 1.00 which is interpreted as accepted/valid. Moreover, the overall validation of both pre- and post-test revealed a V-coefficient value of 0.95, which indicates a valid/accepted material.

### Survey Questionnaire

To further study the effect of IMMVs on their academic performance in terms of control over the learning process, knowledge retention, and intrinsic motivation, a five (5)-point Likert- scale Survey questionnaire adopted and modified from the study of Lacey *et al.* (2021) and Scholtenhuis *et al.* (2020) was utilized. The content of the survey questionnaire was validated as overall and the V-coefficient value revealed a 0.99 rating, which is interpreted as valid/accepted (Ikhsanudin *et al.*, 2018)

### Data collection procedure

The data were obtained through administration of pre-test to all students from both groups for the assessment of their prior knowledge regarding Culture Media Preparation and Gram Staining procedures in a face-to-

face class set-up. After administration of the pre-test, all groups were subjected to an asynchronous class set-up. During the asynchronous class set-up, the researcher posted the research material in the Google classroom of each group. The control group received the Module 3, entitled "Microbiology Laboratory Procedures," which discusses the concept of Culture Media Preparation and Gram Staining Procedure, while the experimental group received the same Module 3 and additional instructor-made micro-lecture videos (IMMVs) as their supplementary materials. The students were strictly instructed to study the topics using the provided materials only and use of other resources were not allowed. For experimental group, they were instructed to watch the IMMVs alone as their supplementary materials. Students were given a week, which is equivalent to two (2) meetings of laboratory hours, to study the module. After a week, the researcher visited each group in a face-to-face class set-up to administer the post-test for the evaluation of their learning regarding the topics using the materials provided.

After the test, the experimental group was asked to answer a Likert-scale survey and few open-ended questions that were included in the survey questionnaire, and they were given a week to finally submit their responses.

### Statistical Treatment

To analyze the effectiveness of micro-lecture videos on the student's performance, the pre-test and post-test results of control and experimental groups were evaluated using the dependent and independent t-test. Furthermore, the survey test results in Likert-scale format were evaluated through mean. The mean of the negative statements from all categories were reversed-coded to obtain consistent interpretation of results. Lastly, the open-ended survey results were summarized, thematized, and used to support the Likert scale survey results of each category.

## RESULTS AND DISCUSSION

### Academic Performance of the students in the experimental and control groups in terms of their Pre-test and Post-test scores

Table 1 presents the pre-test and post-test scores of the students before and after the utilization of the instructor-made micro-lecture videos (IMMVs) on the experimental group and module 3 on the control group. Prior to utilization of the developed learning materials, the highest remark obtained by the experimental group in their pre-test is Very satisfactory but only 8% of the population, most of the students obtained a satisfactory remark and (44%) and moderately satisfactory remark (40%). In contrast with their post-test, the highest remark obtained is outstanding (52%), while the lowest is Moderately satisfactory (1%). Furthermore, the highest remark obtained by the control group in their pre-test is satisfactory (17%) but most of the students obtained a moderately satisfactory remark (59%). In

**Table 1:** Pre-test and Post-test Scores of Students from the control and experimental groups

Experimental Group				Control Group		Remarks	
Scores	Pre-test		Post-test		Post-test		
	f	%	f	%	f		%
37-45	0	0%	13	52.0%	6	21%	Outstanding
28-36	2	8%	8	32.0%	3	10.35%	Very Satisfactory
19-27	11	44%	3	12.0%	10	34.48%	Satisfactory
10-18	10	40%	1	4.0%	9	31.03%	Moderately Satisfactory
0-9	2	8%	0	0.0%	1	3.45%	Needs improvement
Total	25	100%	25	100%	29	100	

comparison to their post-test results, the highest remark obtained was outstanding (21%), most of the students obtained satisfactory (34%) and moderately satisfactory (31%). Moreover, the lowest remark obtained is needs improvement (3%).

Among the two groups, the experimental group shows a significant improvement in their post-test scores after utilization of IMMVs, which 52% of the total participants obtained an outstanding remark on their scores, while 21% of the total participants from the control group obtained an outstanding remark. Moreover, it can be seen in Table 1 that after utilization of the interventions, 75.68% or 76% of the total students from the control group were remarked from satisfactory to needs improvement, and only 24% of the total population were

able to obtain the higher remarks. In comparison to the experimental group, there is no recorded participants with needs improvement remark, and 82% of the total participants were remarked with very satisfactory and outstanding performance.

**Difference between the pre-test and post-test scores of the students in Experimental group**

To further analyze the improvement in the academic performance of the students, the pre-test and post-test scores of the experimental group were used to determine the significant difference between their academic performance before and after utilization of the IMMVs through paired t-test.

**Table 2:** t-test Results Comparing Pre-test and Post-test Scores of Students in the Experimental Group

Test	n	Mean	SD	P-value	Interpretation
Pre-test	25	17.96	6.96	<0.0001	Significant
Post-test	25	34.04	8.15		

Table 2 presents the result of paired *t-test* of the pre-test and post-test scores of the students from experimental group. The students obtained a mean of 17.96 in their pre-test, and a mean of 34.04 in their post-test, which indicates that there is a significant difference between the pre-test and post-test scores of students in the experimental group, where, the calculated t value =  $-11.1146 < t(24) = 2.0639$ , with  $p < .0001$ , in which the post-test scores are higher than the pre-test scores. The result of this analysis shows similarity on the findings of Robles (2019), which experimental groups showed improvement on their academic performance. This implies that providing effective and well-developed IMMVs as supplementary materials of the well-made module are effective in enhancing the students' knowledge and academic performance. The result of this study affirms the findings of Rebong (2022) which self-made videos (instructor-made videos) revealed the highest mean difference compared to the infographics and traditional PPT, which has a similar format to the module utilized in this study. Moreover, it is also observed in the study of Aquino (2022) in which mean percentage score of the experimental group are seen to

have significant difference, which also indicated that utilization of micro-lecture videos increases student's knowledge and idea from a certain course. This implies that providing supplementary materials in learning different courses is essential and can significantly improve the students' academic performance rather than providing them with reading materials, as supplementary materials, like textbooks and PPT, alone (Lestari *et al.*, 2020; Mamman *et al.*, 2018). According to the previous studies, these types of supplementary materials can cause difficulties in the understanding of the students, most especially when it is a biological concept because there are abstract concepts and terms that cannot be simply understand through reading. Therefore, the developed IMMVs of this study are effective supplementary materials.

**Difference between the post-test scores of students in the Control and Experimental groups**

Table 3 reveals a significant difference in the post-test scores of students in the control and experimental group,  $t(51) = 2.0075$ ,  $p = 0.0007$ , in which the students in the experimental group obtained higher scores than

**Table 3:** t-test Results Comparing Post-test Scores of Students in the Control and Experimental Group

Groups	Mean	SD	P-value	Interpretation
Experimental	34.04	8.15	0.0007	Significant
Control	24.89	10.59		

the students in the control group. This implies that the instructor-made micro-lecture videos as supplementary materials effectively enhanced students' academic performance.

The result of this analysis affirms the findings of the previous studies that utilization of micro-lecture videos helped students increase their understanding of the concepts and positively affects their academic performance (Winch *et al.*, 2015; Robles, 2019; Reidl *et al.*, 2021; Rhodemer *et al.*, 2021; Francisco *et al.*, 2022; Nabayra 2022). Moreover, it also agrees that utilizing micro-lecture videos as supplementary materials of a module help students in achieving the learning outcomes of the course topics because it offers positive effect on students' level of attitude in learning biological concepts compared to conventional teaching or module alone (Kareem, 2018).

Furthermore, the result of students' academic performance based on their pre-test and post-test scores provides a different perspective of IMMVs utilization in educational field as it provided a procedural (demonstration) learning video rather than conceptual that previous studies commonly utilized. Thus, it indicates that the concept of micro-lecture videos is applicable in the field of microbiology which practical instruction is the main focus of the learning videos (demonstration). This result is another evidence against

the statement by Thornton *et al.* (2017), because despite the complexity of the selected microbiology laboratory topics step-by-step procedure, the developed micro-lecture videos were able to compressed all significant details needed to learn the concepts and technical skills, and evidently showed a significant improvement in student's performance.

**Effects of utilizing micro-lecture videos on the students' academic performance**

The result from the survey regarding the students' perception on the effect of utilizing IMMVs in learning the microbiology laboratory procedures in their academic performance in terms of control over the learning process, knowledge retention, and intrinsic motivation were summarized and analyzed through mean and standard deviation. Moreover, the data from the open-ended questions were added in support to the result of the statistical analysis.

**Control Over the Learning Process**

Table 4 presents the student's perception on the effect of IMMVs to their academic performance in terms of control over the learning process. The means of negative statements (last five statements) were reverse-coded to maintain consistency with the overall level of agreement and interpretation.

**Table 4:** Likert-scale survey Statistics (Mean and SD) for Control over the learning process

Statements	Mean	SD	Remarks
I was very attentive to the details of the laboratory procedures because it was explained concisely.	4.77	0.53	Strongly Agree
The engaging animations and interactive activities incorporated in the micro-lecture videos helped me to organize my learnings.	4.55	0.67	Strongly Agree
Providing supplementary materials, particularly micro-lecture videos, provides convenience because it is readily available in the classroom.	4.64	0.58	Strongly Agree
I easily understand the details of each laboratory procedure because I can rewatch and relearn it at my own pace.	4.77	0.61	Strongly Agree
I was more excited to learn the laboratory procedures by watching the videos rather than reading the module.	4.18	0.85	Agree
Watching the laboratory procedures is time-consuming.	3.86	1.28	Agree
I was bombarded by learning the laboratory procedures because of the duration of the micro-lecture videos.	3.77	1.27	Agree
I watched the micro-lecture videos first before reading the modules.	2.77	1.69	Neutral
The micro-lecture video contents were overwhelming to understand.	3.41	1.59	Agree
I had to read and watch other online videos because the laboratory procedures were demonstrated in short videos.	4.05	1.33	Agree
Average mean	4.07	1.43	High

Legend		
Scale	Validation Interpretation	Verbal Interpretation
4.21 – 5.0	Strongly agree	Very high
3.41 – 4.20	Agree	High
2.61 – 3.40	Neutral	Moderately high
1.81 – 2.60	Disagree	Low
1.00 – 1.81	Strongly disagree	Very Low

Legend article reference: Rebong (2022)

The effects of utilizing the IMMVs as supplementary materials in learning microbiology laboratory procedures in students' control over the learning process obtained a mean of 4.07 with an SD of 1.43, which indicates a high verbal interpretation. This result indicates that the IMMVs have effectively supported their cognitive loads in processing the complex concept of the laboratory procedures in terms of their control in understanding and learning the topics. Each IMMV contained a detailed and specific laboratory procedure which helped the students to focus on its step-by-step procedure. Brame (2016) stated that learners cognitive load has limited capacity, hence, learning videos must emphasize or focus on the most crucial information that must be processed and acquired. This study's IMMV supported the cognitive load of the students by its specificity on a topic.

Moreover, the student respondents noted significant perceptions of towards IMMVs effect on their cognitive load in processing and learning the laboratory topics. The following subthemes were generated based on the responses of the students:

### Brief and Concise Content

Students agreed that the IMMVs supported their learning process in learning the selected microbiology laboratory topics because the details of the topics were explained concisely and emphasized the important parts of the laboratory topics, as quoted below:

*“Yes. In my own perception, it is easier to learn and digest information about microbiology laboratory procedures through lecture videos especially if the videos were made well, and concise with demonstrations of the procedures like these specific micro-lecture videos given to us.”* (S10)

These statements represent the significance of the micro-lecture video content, specifically the focus of the learning video. It implies that the IMMVs were successful in developing the micro-lecture videos with a clear objective. The results from both Likert-scale and open-ended question survey presents that the contents of the micro-lecture videos fit their learning process because of its conciseness. As supported by Cilliers (2017), learning materials with direct information, visual learning, and interactive activities are more relevant to the Generation Z or the students of the current generation.

### Time-Efficient Procedures

The students also perceived the micro-lecture videos as convenient. From its brief, concise content and specificity on the topic, it made the duration of the micro-lecture videos short, which perceived by the students as time-efficient. Students were asked regarding their difficulty in learning the laboratory procedures through IMMVs and 100% of the students agreed that although the topics were prepared concisely in short videos, they provided sufficient learning; the topics were not overwhelming to process because it did not use a lot of time to watch. Here are some of the notable responses:

*“It favors me, because I’m a good visual learner and along with the concise explanation, it would be much easier for me to catch on with the topic. Lastly, because it only requires bit of my time, it doesn’t feel like forcing myself to watch the video.”* (S4)

*“No, micro-lecture videos actually helped a lot and I think they’re more convenient and they do not require a lot of time to study, because you can learn from them easier since the videos were concise yet informative.”* (S14)

It is clearly stated that the students did not experience any difficulties, yet, they perceived that the conciseness of the content sufficiently provided them learning. Moreover, it can also support the Likert-scale survey statement number six (6) that the learning the laboratory procedure with the aid of IMMV is not bombarding, instead, easy and engaging.

### Engaging Content

In relation to the previous subthemes, the brief, conciseness, and convenience that the IMMV provided to the student conveyed them to be engaged and become enthusiastic in learning the laboratory procedures. The engagement is noted to be influenced by the satisfaction and activation of their audio-visual learning. Students perceived that through IMMV they were able to visualize the procedure which greatly helped them to easily understand and remember the steps-by-step procedure rather than by reading or relying on the module. Below are some of the responses:

*“Yes, I agree, actually for me, it’s much easier to learn a lesson because of the lecture videos(.) I was able to see the actual procedure in the video.”* (S4)

*“Yes. By utilizing videos, we can see the actual procedures/processes involved in microbiology laboratory procedures which is helpful specially in remembering various steps.”* (S6)

These statements prove that the developed IMMVs effectively utilized their media quality effectively as the students perceived that IMMV activated their audio-visual learning. This can indicate that the IMMVs successfully provided the students with active learning environment which is essential in engaging the students and significantly increase students' cognitive load (Cickovska, 2020). Moreover, the learning video provided to the students as either sole or supplementary learning material showed similarity to the study of Deng *et al.* (2014), Guo *et al.* (2014), Chauhan *et al.*

(2015), Rashtchi *et al.* (2021), and Bacolod (2022), which students perceived as engaging. However, differ on the type of content, as this study focused on demonstration of laboratory procedure instead of biological lecture concepts.

Evidently, the IMMVs followed the suggestions of the previous study (Brame, 2016; Chen *et al.*, 2020; Mayer *et al.*, 2020) in eliminating the extraneous process that could cause distraction to the learning of the students, which may lead to difficulties in focusing and understanding the topics. However, it is clearly stated above that there were no distractions in students' learning as the IMMV effectively engaged them to learn and focus on the step-by-step procedure.

### Adaptable for Online and In-Person

In addition to the previous subthemes, the IMMVs were also noted as Flexible in terms of its availability to the students. Since the IMMVs were available online and offline, students mentioned that they could be rewatched as many as they like to understand, remember, and grasp the knowledge the IMMVs are intended to provide. Most of the students mentioned that they watched the videos once (1) to twice (2), and they were able to understand the laboratory procedure. Some of the responses from students are following:

*"I only watched the micro-lecture videos once, and I already understood the proper sequence of gram staining and culture media. the videos were easy to understand"* (S6)

*"I've only watched it twice. After my first watch, I was already able to grasp the knowledge and steps necessary for the microbial procedures. I've only watched for the second time in order to recall some steps that I forgot."* (S10)

Flexibility on the availability of the IMMVs were also considered as convenient to the students in terms of their control on rewatching or replaying the learning videos to satisfy their learning process. The intention to shorten the IMMV duration is anchored to the study of Supriada *et al.* (2020) to help the students process their learning at their own pace and memorize the procedure quickly. This result provides additional evidence that micro-lecture

video is flexible and convenient to students' cognitive load and control over learning (Yang *et al.*, 2016; Linhao, 2018; Brockman *et al.*, 2019; Tianjiao, 2020). Moreover, the results affirm the study of Giannakos *et al.* (2016), Linhao (2018), Lapitan *et al.* (2021), Donner *et al.* (2022), and Lacey (2021) that the video duration of the micro-lecture videos due to segmenting aids students' control over their learning process through rewatching or replaying of videos any time they prefer or as needed to strengthen their knowledge of the specific topic on the micro-lecture videos. Moreover, it promotes individual learning ability which contributes to better learning efficacy.

In summary, IMMVS for both culture media preparation and Gram staining evidently provided significant contributions to the learning efficiency that the students obtain in their post-test. The result of the Likert-scale and open-ended survey indicates that the instructor-made micro-lecture videos have the ability to provide the students the control over their learning process as they both have brief and concise content, time-efficient procedures, flexible procedures, engaging content, and adaptable for online and in-person. These materials can be rewatched as many times as they want until they obtain understanding of the concept. Moreover, the statements also support the result from Table 4 that micro-lecture videos, regardless of the time constraint due to the need to compressing the details into a short video, the students were still able to learn the concepts easily and quickly. The compressed details were not bombarding, and the contents were not overwhelming to understand. This result agrees with the findings of Scholtenhuis *et al.* (2020) that the length and flexibility of the micro-lecture invite student to replay or rewatch the video material often to improve their understanding. Moreover, this study opposes the findings of Pan (2012) and Zhu (2021), in which participants were more favored to learn the concepts with longer videos rather than short videos.

### Knowledge Retention

**Table 5:** Likert-scale survey Statistics (Mean and SD) for Knowledge retention

Statements	Mean	SD	Remarks
I watched the micro-lecture videos several times to become familiar with the procedures.	3.64	1.22	Agree
The micro-lecture video content helped me to memorize the step-by-step procedure.	4.55	0.86	Strongly Agree
I was engaged by interactive activities incorporated in the micro-lecture videos because they challenged me to recall what I had watched.	4.14	0.71	Agree
I was able to organize the proper sequence of the laboratory procedures right after watching the micro-lecture videos.	4.18	0.80	Agree
After watching the micro-lecture videos, the learning activities stimulated my learning memory by visualizing the procedures in the videos.	4.55	0.74	Strongly Agree
I can confidently perform the laboratory procedures because the instructor demonstrated and explained them with obvious skills and knowledge.	3.91	0.75	Agree

Considering the difficulty of Microbiology, I think I will do well in performing the class because the teacher demonstrated the procedures in short but concise micro-lecture videos.	4.18	0.85	Agree
I do not remember any procedure in the micro-lecture videos because they were explained too fast.	4.41	1.05	Strongly Agree
I could not remember the laboratory procedures demonstrated in the micro-lecture videos because I already spent significant time studying the module.	3.91	1.19	Agree
I was confused by the step-by-step procedures because the abstract terms were not explained.	3.82	1.18	Agree
Average mean	4.12	1.14	HIGH

**Legend**

Scale	Validation Interpretation	Verbal Interpretation
4.21 – 5.0	Strongly agree	Very high
3.41 – 4.20	Agree	High
2.61 – 3.40	Neutral	Moderately high
1.81 – 2.60	Disagree	Low
1.00 – 1.81	Strongly disagree	Very Low

Legend article reference: Rebong, M. (2022)

Table 5 presents the student’s perception on the effect of IMMVs to their academic performance in terms of knowledge retention. The means of the negative statements (last three statements) were reverse-coded to maintain consistency with the overall level of agreement and interpretation. Hence, the result showed a mean of 4.12 with an SD of 1.14, which indicates a high verbal interpretation.

The results suggest that both IMMVs effectively contributed to the student’s academic performance in terms of helping them to support and retain their learning from the topics they have watched. It can be supported by the result of IMMVs media quality, as despite the topics being compressed in a short video duration, the IMMVS did not provide the students’ difficulty in learning the step-by-step procedures.

The IMMVs were perceived and remarked by students by the following subthemes:

**Effective guide for learning**

The brief and concise explanation of the laboratory procedures influenced student’s learning process significantly. 100% of the students perceived the well-explained and well-demonstrated procedures in the IMMV guided them thoroughly and correctly to memorize the step-by-step procedures, as illustrated below:

“In terms of familiarizing, I easy(ily) familiarize or remember the step-by-step laboratory procedure through watch(ing) it 2-3 times and it (was) also elaborate(d) and demonstrate(d) well.” (S15)

“Yes, it truly help(ed) me to understand the step-by step procedures of culture media preparation and gram staining procedure because it was explained very clear and thorough.” (S16)

The statements affirm the study of Deng *et al.* (2014), Guo *et al.* (2014), Beheshti *et al.* (2018), and Mayer *et*

*al.* (2020), as this study’s IMMVs provide additional evidence that shortened videos or segmented videos maintain the attention and engagement of the students which help in retaining the knowledge because they can easily focus on one topic.

Moreover, as supported by the responses of the students from the previous category (control over the learning process), the flexibility of the IMMVs to be rewatched as many times as they want contributed to the memorization and finalization of their understanding regarding the step-by-step procedures. Further responses that support the claims are illustrated by students 2 and 3:

“I can watch the procedure as many times as I can until I memorize it.”(S2)

“For me it was a really big help for me to understand the step-by-step procedures using the micro-lecture videos because it enables me to rewatch again and again the videos to follow and to be familiarize the proper steps.” (S3)

**Easy To Familiarize The Procedures**

When students were asked how the IMMV affected their learning terms of familiarizing the step-by-step procedure, some of the students emphasized that the visualization of the laboratory procedures through the micro-lecture videos provided more learning and guidance in familiarizing and retaining the step-by-step procedure than reading the step-by-step procedure in the module. Below are responses by students 4, and 16:

“The actual demonstration in the video actually gives a context of what to do, and along with the instructions it would be understanding the logical steps in doing so that gives the feeling like it is a routine and thus, much easier to remember.” (S4)

“It greatly af(f)ect my learning in terms of familiarizing the step-by-step laboratory procedures. I think by utilizing these videos alone we can already memorize and understand the sequence of those laboratory procedures even without reading the module.” (S16)

Students provide evidence that supplementary materials are essential in strengthening the learning of the students. It affirms that the IMMVs effectively served their purpose as supplementary materials because, some students also mentioned that the learnings acquired through reading are not easily remembered. Moreover, most students taking science laboratory courses often experience the difficulty in following the procedures. However, it is evident from the result of this study that,

IMMV sufficiently addressed a significant hindrance in improving students' academic performance. Similar to the study of Magayanes *et al.* (2023), the well-developed learning videos for physics laboratory were able to improve students' academic performance and address the difficulty in following the procedures encountered by most students.

Thus, watching the IMMVs helped them to retain the learnings in their memory, as stated below by student 18: "The lecture video captures my attention and helps me retain in my memory the learnings I got from the video that I did not understand in the module." (S18)

To effectively utilize the IMMVs as supplementary learning materials, organized, correct, and detailed information must be strictly incorporated into the IMMV. As illustrated by the responses of the students mentioned above, the IMMVs content was well-explained and in a logical sequence, which provided students with a correct and proper sequence of the laboratory procedures that is easy to follow and understand. These mentioned characteristics can be easily obtained through correct and proper demonstration of laboratory procedures.

These notions indicate that the teacher's quality in demonstrating the selected laboratory topics provided a solution to the teacher's quality that is one of the hindrances in the good academic performance of the students mentioned by Mamman *et al.* (2018).

**Provides Sufficient Learning**

With the accurate and precise demonstration of the laboratory procedures by the instructor. The students agreed that the teacher's quality demonstrated in the IMMVs of this study sufficiently provided them with the learnings, as illustrated by students 4 and 16:

"Yes, since it is concerned with the steps itself which has been completely and clearly shown in the video." (S4)

"For me, she (the teacher) was able to demonstrate the laboratory procedures in the micro-lecture videos excellently and was also able to impart her knowledge on performing the procedures very well. It provides me sufficient learnings on how to perform those laboratory procedures." (S16)

Aside from rewatching the IMMVs and teacher quality, the short, interactive activities that were incorporated into each IMMV maintained students' attention and engagement to the students (Deng *et al.*, 2014; Guo *et al.*, 2014; Brame, 2016; Beheshti *et al.*, 2018; Mayer *et al.*, 2020), which stimulated their learning memory by recalling their learning through visualization of the procedures that they have watched. It is also evident in Table 4 (Control over the learning process). Mayer *et al.* (2020) stated that the incorporating generative activities, such as learning by summarizing, self-explaining, or enacting, help students perform better academically. The statement "After watching the micro-lecture videos, the learning activities stimulated my learning memory by visualizing the procedures in the videos." obtained highest remark. It provides evidence that, with a quick stimulation of learning, students' understanding can be enhanced and improved. That, interactive assessment has significant role in retaining students' learning. Monitoring of students' understanding of the concepts or procedures after utilizing various educational methods can lead to better learning outcomes (Palac *et al.*, 2024). In summary, IMMVs as supplementary videos evidently influenced and effectively affect student's learning memory by retaining the knowledge that they have acquired by the well-explained, well-demonstrated laboratory procedures and through rewatching of the videos, which is supported by Scholtenhuis *et al.* (2019), stating that utilizing the video repeatedly and incorporating reflection or activities that will require recalling of learning can offer more help to retain knowledge. This indicates that the quality of IMMV in terms of its content was able to provide students with a guide to reinforce the learnings and skills necessary for mastery. Moreover, teacher's quality in demonstrating the procedure is a requirement to provide students the correct and proper information and skills. Thus, the developed micro-lecture videos are effective learning materials to support students' knowledge retention.

**Intrinsic Motivation**

**Table 6:** Likert-scale survey Statistics (Mean and SD) for Intrinsic Motivation

Statements	Mean	SD	Remarks
Micro-lecture videos of laboratory procedures evoke my interest in performing laboratory diagnosis.	4.18	0.96	Agree
The instructor's narration and demonstration of the laboratory procedures engaged me in learning the procedures.	4.36	0.79	Strongly Agree
I was eager to finish and watch all supplementary materials because it was short and engaging.	4.41	0.80	Strongly Agree
I was motivated to learn the laboratory procedures because the instructor explained it enthusiastically.	4.32	0.78	Strongly Agree
It was really encouraging to learn the micro-lecture videos of the laboratory procedures.	4.55	0.67	Strongly Agree
The presence of the instructor performing the procedure made me interested in learning the actual procedure.	4.50	0.60	Strongly Agree

Micro-lecture videos made me lose interest in learning the microbiology procedures because it requires more time to study.	4.32	1.21	Strongly Agree
My learnings were distracted after watching the laboratory procedures from micro-lecture videos due to its fast narration and transition of animations.	4.14	1.04	Agree
Showing the laboratory procedures through micro-lecture videos did not hold my attention at all.	4.36	0.95	Strongly Agree
I would rather learn the laboratory procedures at school than watch micro-lecture videos.	3.36	1.29	Agree
Average mean	4.25	1.12	VERY HIGH

**Legend**

Scale	Validation Interpretation	Verbal Interpretation
4.21 – 5.0	Strongly agree	Very high
3.41 – 4.20	Agree	High
2.61 – 3.40	Neutral	Moderately high
1.81 – 2.60	Disagree	Low
1.00 – 1.81	Strongly disagree	Ver Low

Legend article reference: Rebong, (2022)

Tables 6 presents the student’s perception of the effect of IMMVs on their academic performance in terms of intrinsic motivation. The means of the negative statements (last four statements) were reverse-coded to maintain consistency with the overall level of agreement and interpretation. Hence, the result showed a mean of 4.25 with an SD of 1.12, which indicates a very high verbal interpretation.

These results suggest that IMMVs positively contributed in providing intrinsic motivation to students, leading to good academic performance. The media quality of IMMVs did not disturb students such as the fast narration and transition of animations due to limited video duration. Despite their limitation, the IMMVs were able to maintain the attention of the students to learn the laboratory procedures. According to the Garber (2019), the short duration of micro-lecture videos will help students maintain their attention on what they are watching and make them more likely to finish the video. Thus, it can be inferred that the developed IMMVs are effective in supplementing the learning of the students because they were able to evoke the interest of the students in learning the laboratory procedures, and they were engaged, encouraged, and motivated by how the instructor delivered the contents enthusiastically.

**Encouraging And Motivating Content**

Discussed in the study of Lestari *et al.* (2020) are the internal factors that influence the difficulties of biology students in learning basic microbiological concepts. One of the internal factors mentioned was the lack of motivation and interest in studying microbiology material. In contrast to the previous study, the IMMVs as supplementary materials successfully evoke the interest of students in performing the laboratory procedure,

which indicates that the IMMVs effectively engaged and caught the attention of the students. Below are some of the responses from students 11, and 16:

“Yes. Micro-lecture videos provide amazing real views about the process that take place during laboratory procedures that makes me want to learn more about it.” (S11)

“Yes, it motivates me to learn more about the other laboratory procedures. Watching those micro-lecture videos make me feel that performing laboratory procedures like culture media preparation and gram staining were not that hard but of course we need to learn it thoroughly and understand its sequence and the correct procedures.” (S16)

According to the statements, the IMMV elevated student excitement to perform the procedure because of its media quality and well-demonstrated step-by-step procedure. The well-developed IMMV prevented the described perception of learning microbiological concepts in the study of Lestari *et al.* (2020). Additionally, despite the complexity and importance of laboratory procedure, the IMMVs evidently invited students’ interest in learning more microbiology laboratory topics. This implies that the developed qualities of the IMMV successfully influenced its effectiveness in inviting the students in learning microbiology laboratory procedures.

Integrating brief, concise, precise, fun, simple, engaging, and enjoyable content is essential in developing the micro-lecture videos. These characteristics are essential to maintain student’s attention and engagement, and enhance knowledge retention (Yang *et al.*, 2016; Cheng, 2015; Brame, 2016; Guo *et al.*, 2014). Evidently, this study was able to integrate the mentioned characteristics and was able to achieved positive results in terms of alleviating the difficulty or fear of learning the microbiology laboratory topics. This result indicates that the developed IMMV successfully and effectively motivates them to increase their eagerness to learn and perform laboratory procedures.

**Captivate Learners’ Attention And Interest**

IMMVs effectively captured students’ attention and interest in learning the microbiological procedures, in contrast to the findings of Lestari *et al.*, (2020). The students expressed enthusiasm for learning the microbiology laboratory procedures because the information provided in the learning videos was not overwhelming and easy to grasp, it can be supported

by the result of the Likert-scale survey from Table 6. Students' enthusiasm led to their engagement and made them feel excited and interested in learning microbiology laboratory procedures, as illustrated below by students 16, and 17:

*"I was quite excited about utilizing the micro-lecture concept in learning microbiology laboratory procedures because the demonstration that were performed in the videos were very easy to grasp and it does not contain and present overwhelming information all at once."* (S16)

*"Very much glad and excited, because I knew I can spend my whole day on my phone(.) and watching micro-lecture videos really caught my attention and also I was able to learn new things."* (S17)

This indicates that the developed qualities of the IMMV effectively utilized in influencing students' interest in learning the microbiology laboratory procedures. It affirms the findings of the previous studies that utilizing educational videos capture more interest and provides enthusiastic learning to students (Carmichael *et al.*, 2020; Yang *et al.*, 2016). Moreover, it affirms the effective application of micro-lecture videos in teaching biology and microbiology topics (Kareem, 2018; Wang *et al.*, 2019). However, in contrast to the previous studies, IMMV was utilized to provide demonstration video not conceptual. This implies that micro-lecture video can be utilized in teaching abstract laboratory procedures and more effective than longer videos. That, although microbiology laboratory procedures are abstract and strict in terms of its sequence, it can still capture students' engagement and interest in learning them.

As evident below, students 6 and 8 mentioned that they were excited and enthusiastic that micro-lecture videos were utilized in teaching microbiology laboratory topics, considering the duration of teaching and learning it in the actual setting:

*"Super (enthusiastic), because I know that this microbiology laboratory procedures can be used to our forthcoming research studies."* (S6)

*"It made me excited and happy that such video is utilized in our learnings since laboratory procedures are so long and sometimes, boring to read."* (S8)

The result of this study indicates that even though laboratory procedures have abstract concepts of procedures to offer, they can also provide motivation to the students to learn the laboratory procedures effectively and efficiently. Moreover, it indicates that encouragement, motivation, enthusiasm, and excitement have influence on students' eagerness to learn, particularly laboratory procedures, similar to the result in the study of Beheshti *et al.* (2018). It also influenced the concentration level of the students in learning/studying the topics, which is believed to have significant impact in students' academic performance, particularly helped in obtaining "better remarks". Moreover, other than activating the cognitive skills, the IMMV of this study can effectively guide the non-cognitive skills, or the technical skills of the students.

### **Creates A Significant Learning Impact For Students**

Overall, with the qualities and effects of IMMV to students' academic performance in terms of control over the learning process, knowledge retention, and intrinsic motivation, students perceived that utilizing IMMV in learning microbiology laboratory procedures had a significant impact on their learning, as stated by students 4, and 16:

*"Definitely, if I can watch a simplified version but sufficient informative videos it further cements my actual understanding of a certain topic which increases my overall mastery and allow me to be flexible in what I do in microbiology laboratory."* (S4)

*"In my perspective, the usage of micro-lecture videos made a great impact in learning microbiology topics. These really help me to understand the procedures without struggling."* (S16)

This affirms the claims of Winch *et al.* (2015) that micro-lecture videos aid students struggling to understand complex topics, particularly in the context of microbiology. Also, Wang *et al.* (2019) stated that multimedia teaching must be utilized in teaching medical microbiology to make abstract and complex concepts to understand. Multimedia can stimulate students' interest and enthusiasm in learning microbiological concepts. This indicates that the developed IMMVs were able to stimulate students' audio-visual learning skills because the main and detailed concepts that are supposed to be abstract and complicated to understand in traditional teaching approach, are delivered with engaging and easy-to-understand content by the IMMVs.

### **Advanced Learning Efficiency**

When students were asked if they would prefer to learn the laboratory procedures at school than watch the micro-lecture videos of the laboratory procedures, the survey result showed a neutral interpretation, which indicates that students some students still preferred learning the laboratory procedures in an actual class setting. Students mentioned that traditional teaching is better paired with micro-lecture video-assisted teaching because through traditional teaching method, questions that may arise can be answered immediately, and with the aid of the micro-lecture assisted-teaching, the knowledge can be confirmed through visualization of the procedure. Some of the notable response from students 4:

*"Micro-lecture video assisted teaching. Because, unlike the traditional which is a one-off and maybe review in another session, micro-lecture video is readily accessible every time and doesn't consume too much time which is very helpful especially if I was busy with lot of requirements, I can still study it in the meantime. Combining this with the traditional teaching allow my understanding to be ingrained in my mind."* (S4)

The result showed that both traditional and micro-lecture video-assisted teaching is still preferred and best practiced in the classroom. The utilization of micro-lecture videos during the traditional lecture-discussion assists students in recalling or relearning the concepts discussed during the traditional teaching. The traditional teaching approach is still necessary because it offers more

discussion of the topics than watching a short video lecture. As a goal of this study, the IMMV is expected to support students' knowledge after reading the module. It supports the students' need in understanding the laboratory procedures.

### Provides Convenience For Student's Learning

Moreover, it is also perceived by the student that instructor-made micro-lecture videos are better prepared for the class rather than relying on micro-lecture videos that are found on many online websites, including YouTube. As students 1 and 16 stated:

*"Yes, because I want to learn better and appreciate the laboratory procedures in microbiology which I cannot achieve by merely relying on reading modules. Although some procedure videos are present on YouTube it's hard to find and the materials are not always accessible to students so it will be better if the instructor does the procedure using materials that are easily found?" (S1)*

*"Yes, for me the micro-lecture videos help me to easily grasped the sequences of the laboratory procedures that were demonstrated. Unlike the videos available on YouTube these micro-lecture videos are indeed great and easy to understand and the materials are also accessible." (S16)*

One of the main goals of this study is to provide convenience to students and to address difficulty in finding available supplementary materials that has free subscription, short duration, utilizes similar equipment and laboratory materials as the school, and provides similar environment to the actual laboratory at school. It may influence students' attention and interest in learning as the learning materials are well-developed and well-provided to them. That, it saves their time from searching for similar procedures online.

Thus, this finding indicates that the IMMV has successfully addressed this main concern in teaching microbiology laboratory procedures. It implies that instructor-made learning videos advances in providing direct learning to the students as it shows similar environment to them compared to the available learning videos online.

In summary, the development of IMMV showed a significant impact to students' academic performance as shown in their scores and it was evidently influenced by the demonstration, audio, media, and production style qualities of the IMMV. Thus, it can be concluded that utilizing micro-lecture videos in teaching microbiology laboratory topics is effective and can improve students' performance.

### CONCLUSIONS

The utilization of developed instructor-made micro-lecture videos (IMMV) in teaching selected microbiology laboratory procedures among the tertiary level students of BS Biology program revealed significant differences in students' academic performance. Therefore, the utilization of developed micro-lecture videos in teaching selected microbiology laboratory topics effectively improve students' academic performance. That,

utilization of IMMV as supplementary materials, can influence students' eagerness to learn any microbiology laboratory topics than learning them through a developed module only.

Moreover, in providing supplementary materials to support students' cognitive and non-cognitive skills, it is necessary to provide an engaging, interacting, has specific topic and provides reliable, accurate, and precise information that are discussed briefly and concisely in the IMMV. Development of the IMMV played a significant role in the effectivity of the supplementary materials in improving students' academic performance. That, when IMMV provides active learning environment with its engaging, interacting, and motivating delivery, students tend to maintain their interest in learning leading to a good academic performance. Therefore, establishing a well-developed micro-lecture video can sufficiently and effectively help students improve their academic performance.

Furthermore, this study concludes that instructor-made micro-lecture videos (IMMV) is not only effective in teaching conceptual topics but also effective in teaching procedural topics similar to microbiological procedures used in this study.

It is highly suggested that a similar study be conducted in which micro-lecture videos are utilized to teach laboratory procedures, particularly the utilization of micro-lecture videos as the sole learning material in teaching a particular topic. Moreover, the academic performance of the students can be compared through the utilization of micro-lecture videos during a blended-learning class set-up and actual demonstration at school. Furthermore, future researchers may utilize this study's developed IMMV for other-related research.

### Acknowledgement

I want to extend my gratitude to the BS Medical Biology students of Palawan State University who participated and made this study possible. To my dear adviser for his sincerity and dedication to reviewing every detail of this study and for making this research meaningful.

### REFERENCES

- Andrews, J., de Los Rios, J., Rayaluru, M., Lee, S., Mai, L., Schusser, A., & Mak, C. (2020). Experimenting with At Home General Chemistry Laboratories During the CoViD-19 Pandemic. *Journal of Chemical Education*, 97(7), 1887-1894. <https://pubs.acs.org/doi/10.1021/acs.jchemed.0c00483>
- Aquino, J. S. (2022). Development and Utilization of Instructional Video in Teaching Statistics and Probability. *International Journal of Research Publications*, 103 (1), 675-688. <http://doi.org/10.47119/IJRP1001031620223406>
- Beheshti, M., Taspolat, A., Kaya, O. S., & Sapanca, H. F. (2018). Characteristics of instructional videos. *World Journal on Educational Technology: Current Issues*, 10(1), 61-69.

- Blacer-Bacolod, D. (2022). Student-Generated Videos Using Green Screen Technology in a Biology Class. *International Journal of Information and Education Technology*, 12(4), 339-345. <https://doi.org/10.18178/ijet.2022.12.4.1624>
- Brame, C. J. (2016). Effective educational videos: Principles and guidelines for maximizing student learning from video content. *CBE—Life Sciences Education*, 15(4), es6 1-6. <https://doi.org/10.1187/cbe.16-03-0125>
- Brockman, R. M., Taylor, J. M., Segars, L. W., Selke, V., & Taylor, T. A. (2020). Student perceptions of online and in-person microbiology laboratory experiences in undergraduate medical education. *Medical education online*, 25(1), 1710324. <https://doi.org/10.1080/10872981.2019.1710324>
- Campbell, L. O., Heller, S., & Pulse, L. (2020). Student-created video: an active learning approach in online environments. *Interactive Learning Environments*, 30(6), 1145–1154. <https://doi.org/10.1080/10494820.2020.1711777>
- Carmichael, M., Reid, A-K., & Karpicke, J.D. (2020) Assessing the Impact of Educational Video on the Student Engagement, Critical Thinking, and Learning: *The Current State of Play*. Sage Publishing, 7-13.
- Chauhan, J., Taneja, S., & Goel, A. (2015, October). Enhancing MOOC with augmented reality, adaptive learning and gamification. In 2015 IEEE 3rd International Conference on MOOCs, *Innovation and Technology in Education (MITE)*, 348-353. <https://doi.org/10.1109/MITE.2015.7375343>
- Chen, H-T. M., & Thomas, M. (2020). Effects of learning video styles on engagement and learning. *Education Technology Research Development*, 68, 2147-2164. <http://dx.doi.org/10.1007/s11423-020-09757-6>
- Cheng, C. (2015, November). Thinking on the problems in design and application of micro-lecture. *Proceedings of the 2015 International Conference on Economics, Management, Law and Education*, 383-386. <https://doi.org/10.2991/emle-15.2015.88>
- Cickovska, E. (2020). Understanding and teaching Gen Z in higher education. *Horizons- International Scientific Journal (Series A)*, 26(3), 275-290. <https://doi.org/10.20544/HORIZONS.A.26.3.20.P22>
- Cilliers, E. J. (2017). The challenge of teaching generation Z. *PEOPLE:International Journal of Social Sciences*, 3(1), 188-198. <https://doi.org/10.20319/pijss.2017.31.188198>
- Cowan, M. K. (2015). *Microbiology: A Systems Approach* (4th International Edition). McGraw Hill Higher Education.
- Deng, H., Shao, Y., Tang, Y., & Qin, Z. (2014). How micro lecture videos trigger the motivation of learners of Coursera: A comparative study based on ARCS mode. *2014 International Conference of Educational Innovation through Technology*, 117-122. <https://doi.org/10.1109/EITT.2014.28>
- Fauzi, A., Rosyida, A., Rohma, M., & Khoiroh, D. (2021). The difficulty index of biology topics in Indonesian Senior High School: Biology undergraduate students' perspectives. *Jurnal Pendidikan Biologi Indonesia (JPBI)*, 7(2), 149-158. <https://doi.org/10.22219/jpbi.v7i2.16538>
- Flemming, H. C., & Wuertz, S. (2019) Bacteria and archaea on Earth and their abundance in biofilms. *Nature Reviews Microbiology*, 17(4), 247–260. <https://doi.org/10.1038/s41579-019-0158-9>
- Francisco, Jr. L. M., & Prudente, M. S. (2022). Improving Student's Conceptual Knowledge In Online Distance Learning Through The Use Of Micro-Lectures: A Photosynthesis Example. *Innovative Technology and Management Journal*, 5(1), 11-21.
- Giannakos, M. N., Krogstie, J., & Aalberg, T. (2016). Video-based learning ecosystem to support active learning: application to an introductory computer science course. *Smart Learning Environments*, 3(1), 1-13. <https://doi.org/10.1186/s40561-016-0036-0>
- Guo, P., Kim, J., & Rubin, R. (2014). How Video Production Affects Student Engagement: An Empirical Study of MOOC Videos. *Proceedings of the first ACM conference on learning @ scale conference*. Association for Computing Machinery, New York, NY, USA, 41-50. <https://doi.org/10.1145/2556325.2566239>
- Hadiprayitno, G., Muhlis, & Kusmiyati. (2019). Problems in learning biology for senior high schools in Lombok Island. In *Journal of Physics: Conference Series*, 1241 (1). <https://doi.org/10.1088/1742-6596/1241/1/012054>
- Ikhsanudin, I., & Subali, B. (2018). Content validity analysis of first semester formative test on biology subject for senior high school. *Journal of Physics. Conference Series*, 1097, 012039. <https://doi.org/10.1088/1742-6596/1097/1/012039>
- Joji, R. M., Kumar, A. P., Almarabbeh, A., Dar, F. K., Deifalla, A. H., Tayem, Y., ... & Shahid, M. (2022). Perception of online and face to face microbiology laboratory sessions among medical students and faculty at Arabian Gulf University: a mixed method study. *BMC Medical Education*, 22(1), 1-12.
- Kareem, A. A. (2018). The use of multimedia in teaching biology and its impact on students' learning outcomes. *The Eurasia Proceedings of Educational and Social Sciences*, 9, 157-165.
- Lacey, K., & Wall, J. G. (2021). Video-based learning to enhance teaching of practical microbiology. *FEMS Microbiology Letters*, 368(2), 1-10. <https://doi.org/10.1093/femsle/fnaa203>
- Lapitan Jr, L. D., Tiangco, C. E., Sumalinog, D. A. G., Sabarillo, N. S., & Diaz, J. M. (2021). An effective blended online teaching and learning strategy during the COVID-19 pandemic. *Education for Chemical Engineers*, 35, 116-131. <https://doi.org/10.1016/j.ece.2021.01.012>
- Lestari, L., & Putri, D. H. (2020). An Analysis of Factors Causing Learning Difficulties of Biology Students in the Microbiology Subject, Universitas Negeri Padang. *International Conference on Biology, Sciences and Education (ICoBioSE 2019)*, 253-258. <https://doi.org/10.2991/absr.k.200807.051>
- Linhao, S. (2018). Design of Micro-lecture for College

- Chemistry Majors and Prospect of Its Teaching Application. *Proceedings of the 2018 3rd International Conference on Education, E-learning and Management Technology (EEMT 2018)*, 646-650. <https://doi.org/10.2991/iceemt-18.2018.126>
- Loughlin, W. A., & Cresswell, S. L. (2021). Integration of Interactive Laboratory Videos into Teaching Upper-Undergraduate Chemical Laboratory Techniques. *Journal of Chemical Education*, 98(9), 2870-2880. <https://doi.org/10.1021/acs.jchemed.0c01493>
- Magayanes, R. L. S., Sarmiento, B. G., Miguel, J. R. P., Diaz, J. J. G., Argañosa, J. B., Brillantes, L. C., Luyahan, J. T., Barachina, J. M. D., & Oca, M. D. D. (2023). Utilization of Student-Created Videos for Laboratory Activities in Physics. *American Journal of Education and Technology*, 4(2), 116-123. <https://doi.org/10.54536/ajet.v2i2.1561>
- Makransky G., Thisgaard M. W., Gadegaard, H. (2016). Virtual Simulations as Preparation for Lab Exercises: Assessing Learning of Key Laboratory Skills in Microbiology and Improvement of Essential Non-Cognitive Skills. *PLoS ONE*, 11(6). <https://doi.org/10.1371/journal.pone.01558955>
- Mamman, S. M., Misau, A. A., & Agboola, M. (2018). Pedagogical Approaches and Effective Teaching in Biology Education: A Review of Teacher's Roles and Responsibilities. *ATBU, Journal of Science, Technology, & Education*, 6(4), 277-283.
- Manap, A., Sardan, N., & Rias, R. (2013). Interactive Learning Application in Microbiology: The Design. *Procedia-Social and Behavioral Sciences*, 90, 31-40. <https://doi.org/10.1016/j.sbspro.2013.07.062>
- Mayer, R. E., Fiorella, L., & Stull, A. (2020) Five ways to increase the effectiveness of instructional video. *Association for Educational Communications and Technology*, 68, 837-852. <https://doi.org/10.1007/s11423-020-09749-6>
- Nabayra, J. (2022). YouTube-based teacher-created videos for online mathematics learning during the pandemic and its effect to students' mathematics performance. *Webology*, 19(2), 1380- 1390.
- Palac, N. C. J. C., Baldo, K. J. C, Socorro, N. M. G., & Berame, J. S. (2024). Determining the Intermediate Grade Pupils' Perceived Learning Difficulties in Science Class Experiences. *American Journal of Education and Technology*, 4(1), 1-11. <https://doi.org/10.54536/ajet.v4i1.3886>
- Rashtchi, M., Khoshnevisan, B., & Shirvani, M. (2021). Integration of Audiovisual Input via TED-ED Videos and Language Skills to Enhance Vocabulary Learning. *MEXITESOL Journal*, 45(1), 1-18. <http://dx.doi.org/10.61871/mj.v45n1-12>
- Rebong, M. (2022). Micro-Lecture Teaching To Improve The Learning Of Junior High School Learners In Science. *International Journal of Research Publications*, 102(1), 902-911. <https://doi.org/10.47119/IJRP1001021620223333>
- Riedl, A., Yeung, F., & Burke, T. (2021). Implementation of a Flipped Active-Learning Approach in a Community College General Biology Course Improves Student Performance in Subsequent Biology Courses and Increases Graduation Rate. *CBE—Life Sciences Education*, 20(2), ar30. <https://doi.org/10.1187/cbe.20-07-0156>
- Robles, A. C. M. O., & Acedo, E. M. (2019). Development and Validation of Educational Video Tutorials for 21st Century Secondary Learners. *Asian Journal of Multidisciplinary Studies*, 2(2), 42-49.
- Scholtenhuis, L., Vahdatikhaki, F., & Rouwenhorst, C. (2020). Flipped Microlecture Classes: Satisfied Learners and Higher Performance. *European Journal of Engineering Education*, 46(3), 457-458. <https://doi.org/10.1080/03043797.2020.1819961>
- Shuping, L., Taotang, L., & Jie, Z. (2019). Research on Application of Microlecture to Teaching Reform. In *IOP Conference Series: Materials Science and Engineering*, 563(4). <https://doi:10.1088/1757-899X/563/4/042029>
- Supriadi, F., Agreindra Helmiawan, M., Yan Sofiyani, Y., & Guntara, A. (2020). A Model of Virtual Learning Environments Using Micro-Lecture, MOODLE, and SLOODLE. *8th International Conference on Cyber and IT Service Management (CITSM), Pangkal, Indonesia*, 1-4. <https://doi:10.1109/CITSM50537.2020.926875>
- Thornton, S., Riley, C., & Wiltrout, M. E. (2017). Criteria for video engagement in a biology MOOC. In *Proceedings of the Fourth (2017) ACM Conference on Learning @ Scale*, 291-294. <https://doi.org/10.1145/3051457.3054007>
- Tianjiao, L. (2020). Design and Application of Micro-lecture in Personalized Teaching of Computer Network. *Journal of Physics: Conference Session*, 2-3. <https://doi:10.1088/1742-6569/1678/1/012108>
- Wang, H. Y., Zhang, F. B., Delidaer, K., Cheng, F., Zhao, Y. J., & Ding, J. B (2019). Using a Variety of Modern Teaching Methods to Improve the Effect of Medical Microbiology Teaching. *Procedia Computer Science*, 154, 617-621. <https://doi.org/10.1016/j.procs.2019.06.097>
- Winch, J. K., & Cahn, E. S. (2015). Improving student performance in a management science course with supplemental tutorial videos. *Journal of Education for Business*, 90(7), 402-409. <https://doi.org/10.1080/08832323.2015.1081865>
- Yang, Y., Zhang, X., & Tian, D. (2016). Analysis on Micro-lecture Design in Modern Distance Education. In *2016 2nd International Conference on Economics, Management Engineering and Education Technology*, 87, 380-383. <https://doi.10.2991/icemeet-16.2017.79>
- Zheng, H. (2022, February 17). *Short and Sweet: The Educational Benefits of Microlectures and Active Learning*. The Voice of the Higher Education Technology Community Educause Review. <https://er.educause.edu/articles/2022/2/short-and-sweet-the-educational-benefits-of-microlectures-and-active-learning>.