Improving Students' Achievement of Learning Competencies in Mathematics through Micro-Lecture via ED Puzzle

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ABSTRACT

Students' achievement of learning competencies in their self-paced learning in asynchronous online learning posed a challenge. The micro-lectures delivered through ED Puzzle intend to help students to achieve the learning competencies required in the lesson. This research used an action research design, and mixed-method investigation to determine the effectiveness of the use of micro-lectures via ED Puzzle in delivering the lessons in Mathematics during an asynchronous online class to improve students' achievement of its learning competencies. This study utilized purposive sampling to select its participants from Grade 11- Integrity Science Technology Engineering and Mathematics (STEM) students in Bukidnon State University-Secondary School Laboratory during the second semester of the school year 2021-2022. A researcher-made questionnaire and open-ended survey questions were used to gather the needed data for the study. The data were analyzed using mean, paired t-test, and thematic analysis. Results showed that watching micro-lectures helped improve the level of competence on the differentiation rules among the students from "did not meet expectations" to "very satisfactory." It revealed that there is a significant difference between pre-test and post-test scores based on paired t-tests. Meanwhile, the data from the open-ended questions indicated the experiences of the students in using micro-lecture via ED Puzzle that include content-rich micro-lectures, high learning engagement, provides flexibility in learning, and open new learning delivery experiences. Based on the findings, the researchers suggest that teachers should explore varied modes of learning delivery to improve the achievement of learning competencies in Mathematics and give utmost consideration to the learners' needs in asynchronous online learning. Thus, technology integrated with thoughtful discourse and pedagogies of a teacher promises a positive impact on the teaching and learning experience amidst the pandemic.

KEYWORDS: *micro-lecture, ED Puzzle, instructional videos, learning competency, differentiation rules, asynchronous online learning*

INTRODUCTION

Mathematical competencies are useful in dealing effectively with mathematical problems in daily life. It allows people to productively use their mathematical knowledge in applied and practical situations. Moreover, it is beneficial to the students that they are well-equipped with mathematical learning competencies. Learning competencies as defined by the Department of Education (DepED) are the "knowledge, understanding, skills, and attitudes that students need to demonstrate in every lesson and/or learning activity". Students need these competencies to expand on what they already know, how they think, and what they can do. Hence, these are what they need to know in order to build the skills needed for their subsequent grade level and eventually develop life-long learning and use it meaningfully.

There were rapid changes brought about by the global pandemic, however, the importance of core topic competency and mastery in mathematics cannot be underestimated (Luzano, 2020). The 2018 Program for International Student Assessment (PISA) results revealed that the Philippines scored 353 in mathematics, ranked bottom among the 79 countries of the Organization for Economic Co-operation and Development (Mocon-Ciriaco, 2019). The promotion of students without achieving competencies needed for the level is one of the factors of having a poor math performance (Luzano, 2023). In addition, the lack of mastery and learning among students on some learning competencies contributed to poor performance during National Achievement Tests and other related assessments (Linog, Lahoylahoy, & Alguno, 2013). The declining performance of Filipino students in mathematics triggered the need to elevate the quality of mathematics education in the Philippines (Luzan0 & Ubalde, 2023).

The abstractness of mathematics plus the sudden shift of face-to-face to distance learning posed serious effects for the learners (Pang-an, et al., 2022). As a scenario, if a class schedule only allows for one synchronous online session per week, teachers and students will expected to rely increasingly on asynchronous learning to complete the curriculum (Aranzo, et al., 2023). With this, students will be forced to practice self-regulated learning with little guidance from their teachers, which may result in feelings of isolation and a lack of enthusiasm in learning (Russo & Benson, 2005). Therefore, the online learning materials should serve to be effective in delivering the lessons in a manner that is clear and appropriate to learners' needs or else a poorly designed online learning materials will create another problem to learners such as confusion (Mayer, 2014; Kizilcec et al., 2015; Casanova, et al., 2023).

In the context of Bukidnon State University-Secondary School Laboratory during the series of teaching demonstration conducted by the researchers, they found out that several students experiencing difficulty in achieving the learning competencies in mathematics. About 51% of the class was not able to achieve the learning competencies. Hence, the cyclical process of action research was deemed necessary and appropriate to address the current learning gaps.

The principles of cognitive load theory have been effectively applied to the development of multimedia learning resources for use in online learning (Mayer & Moreno, 1998). The cognitive load theory states that the human mind can only process very few information at a given time (Sweller, 2003). Hence, long video lectures, for example, that jam too much material into a multimedia presentation, actually hinder the mind's ability to create meaningful learning (Mayer, 2014). In addition, Climient et al., (2013) reported to be useful

to replace academic approaches in math education with active techniques and modern technology such as videos. In fact, extensive studies on video-assisted learning have found that vicarious learning is recommendable (Bandura, 1971). Results shows that there is a tendency of students to understand better by observing others than by doing it by themselves. A total of 53 peer-reviewed papers showed that video helped students comprehend concepts and ideas better, which led to improved results (Kay, 2012).

To bridge the current learning gaps, micro-lecture was utilized. Liu & Wang (2013) summarized the definition of micro-lectures as a short video presentation that sharply focuses on a specific topic, teachers make it to fit the students' needs, and it is in line with the learning competencies they must achieve. The video lecture should last appropriately 5-10 minutes, with a minimum of 1-2 minutes and a maximum of no more than 20 minutes (Peng, 2019). According to Wei, Qiu, and Yu (2017), micro lectures are different from other educational videos in a way that a) it encourages fragmented learning, b) it enables students to concentrate due to its short runtime, c) it only concentrates on certain parts of the lesson to allow more focus, and d) it supports mobile-learning due to its small file size. Oktaviyanthi and Herman (2016) concluded the positive effect of micro-lecture in utilizing the self-pace learning in Calculus among students that they are not only improving of their own learning, but additionally they are more engaged in learning and changed the way they learn more independently. A parallel study was undertaken by Kinnari-Korpela (2015) who utilized micro-lecture in enhancing the mathematics learning-experiences on differential and integral calculus course for engineering students. The findings showed that 89% of the students felt the meaning of mathematics' learning through video, they have more time to think and understand the content. Moreover, the study suggested that the use of short videos is suitable method to present mathematics contents. Meanwhile, Cui (2020) accentuated that the integration of micro-lecture enhances students' interest in learning and improve students' ability of mathematical communication and reflection. Hence, micro-lecture could be an appropriate content delivery for asynchronous learning.

Meanwhile, the micro-lectures were also uploaded in an educational platform called ED Puzzle that will additionally help students to achieve their learning competencies. ED Puzzle is an educational platform that allows teachers to make use of videos to facilitate an interactive and engaging learning session. The tool makes it viable to do the following: edit videos and insert questions (formative assessment), audio, test and links if necessary. On the study conducted by Kuckian et al., (2022) entitled, Utilization of ED Puzzle: An interactive tool in teaching practices, there is a potential brought by ED Puzzle activities that solidifies its role in strengthening self-regulated skills of students. It further showed that the activities allow low achievers to learn those skills. It also helps in increasing development of mathematical, analytical, and cognitive skills. The same result was reported by Giyanto et al (2020) that EdPuzzle can improve students' concept mastery and effective on online asynchronous learning. Thus, it serves to equip the learners with adequate competence, ability, and skills that last outside the classroom.

Having discussed the current conditions, the aim of this action research is to determine the effectiveness of the use of micro-lectures via ED Puzzle in delivering the lessons in mathematics during an asynchronous online class to improve the achievement of learning competencies among Grade 11- Integrity Science Technology Engineering and Mathematics (STEM) students in Bukidnon State University Secondary School Laboratory during the

Page : 122

second semester of the school year 2021-2022. Moreover, this study limits only on the lesson, differentiation rules in Basic Calculus to be delivered in the implementation of the study.

INNOVATION, INTERVENTION, AND STRATEGY

This project was developed on the construct that the lesson should be delivered easily, but meaningfully to assist students in achieving the learning competency required of the lesson. Henceforth, the researchers, propose the use of micro-lecture via ED Puzzle. The said intervention material is a video-based instructional tool developed by the researchers that was modified in such a way that the learners will have the hands-on experience of doing the specific competency in Basic Calculus. The researcher-developed intervention tool was composed of: (1) lecture area and (2) formative assessment area based on the learning competency. The lecture area aims to bring the students to its substantial discussion of the topic to help them acquire adequate knowledge towards the achievement of the learning competency. Meanwhile the formative assessment area (multiple choice and open-ended questions) measures the students' mastery of the learning competency required of the lesson by using an interactive learning approach provided by the ED Puzzle. The implementation first required the preparation of micro-lectures about differentiation rules in Basic Calculus by following existing literatures discussing about its development and design-elements that help in reducing cognitive load among learners. The micro-lectures were uploaded in the ED Puzzle to modified it. ED Puzzle was utilized in the duration of implementation to monitor the students' self-regulated learning. Through ED Puzzle, the researchers inserted an appropriate assessment tool in the video that is aligned to the learning competency of the lesson.

Developing of Micro-Lectures

The researchers followed the rules established by Penrose (2008), who stressed the video's very short runtime as its distinguishing attribute in creating and delivering the micro-lectures. Other practitioners' additions to the format, such as the addition of graphical components to make it more engaging, were also taken into account (Yang, Zhang, & Tian, 2016). The micro-lectures should, above all, conform with the learning theories that it promotes. Due to this, the researchers followed a checklist developed in accordance with the frameworks of Mayer and Moreno (2003) in how to design multimedia presentations that reduce cognitive load. The said checklist, entitled A Research-Based Checklist for Development and Critique of STEM Instructional Videos (Seethaler, et al., 2020), was used by the researchers in the different facets of micro-lecture development. A framework of the development process by Francisco & Prudente (2021) as shown below was adapted.

The first stage in creating micro-lectures is to write a script (Liu & Wang, 2013). The researchers used the DepEd's MELCs to identify the learning competencies of the topic differentiation rules in Basic Calculus that should be included in the video. The researchers used a smartphone capable of recording in resolution of 2k in capturing the scenes and recording the discussion. The PowerPoint presentation was also utilized to create an animated slide. In assembling everything into a coherent presentation, a video editor called Movavi was used. Then the videos were validated by the three (3) mathematics teachers who are experts in content-knowledge and multimedia presentations. After completed, the videos were shared to the students via ED Puzzle.
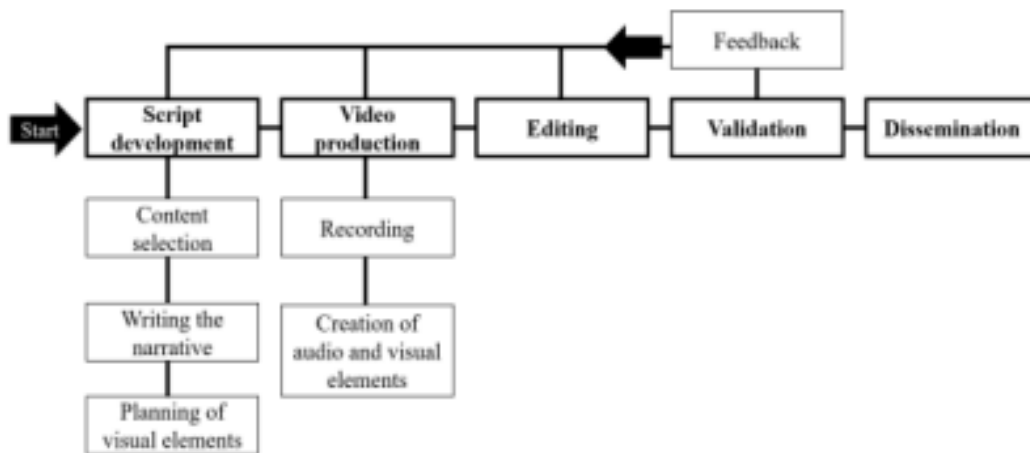
Figure 1. *Framework for micro-lecture development*

Implementation

The implementation ran for three (3) weeks which covered the third week of March 2022 to the second week of April 2022. It utilized an asynchronous online session. The researchers oriented the participants during synchronous period for basic calculus using Zoom video conferencing. This was when the pre-test, which was encoded using google forms, was shared to the students through a URL link. The students' progress on watching the micro-lecture videos were monitored through ED Puzzle. No exact deadlines were set for them to finish the videos, only that they were expected to finish everything in a span of three (3) weeks. The post-test served as the quiz that covered the lesson about differentiation rules. Due to similarity with the pretest in structure and specification, the questions were shuffled.

RESEARCH QUESTIONS

The action research determined the effectiveness of the use of micro-lectures via ED Puzzle in delivering the lessons in mathematics during an asynchronous online class to improve students' achievement of its learning competencies. It also aims to answer the following research questions:

   1. What is the students' level of competence on differentiation rules before and after viewing micro-lectures via ED Puzzle?
   2. Is there a significant difference between the students' level of competence on differentiation rules before and after using micro-lectures via ED Puzzle?
   3. What are the students' learning experiences in using micro-lectures via ED Puzzle?

ACTION RESEARCH METHODS

An action research design, mixed method investigation was employed on this study.

Participants and/ or other Sources of Data and Information

This study was conducted in Bukidnon State University-Secondary School Laboratory (BukSU-SSL) among the Grade 11-Integrity Science Technology Mathematics and Engineering (STEM) students who were chosen as the participants of the study. However, only 20 students voluntarily participated in the conduct of the study. Hence, purposive sampling was employed. The said section has an asynchronous class to complete the curriculum. Commonly, during the asynchronous class, recorded lecture videos about the topic were uploaded to the Google Classroom for their reference that less than or more than an hour. Thus, students were bombarded with too much information, cannot interact in real-time, and the teacher cannot assess if the student do the interactive activity in the recorded lecture video to achieve the target competency. So, the researchers made ways to help the students to achieve the mathematical competencies by having short videos delivered in an interactive way.

For ethical consideration, participants' informed consent was obtained before data collection in which no force will be made to compel them to participate, assuring that their anonymity and responses will be secured.

Data Gathering Methods

A researcher-made questionnaire and open-ended survey questions were used as the instrument to gather the data needed in the study. These were validated by experts. The 20-item researcher-made questionnaire was utilized for gathering quantitative data in the pre-test and posttest while the open-ended survey questions inserted in the micro-lecture videos posted in the ED Puzzle was used to gather qualitative data. On the other hand, the micro lecture videos used were validated by the three (3) mathematics teachers who are experts in multimedia presentations and content-knowledge. After finalizing the material, the study was started.

In measuring of the participants' level of competence on differentiation rules, the researchers converted the obtained mean scores in the pre-test and posttest of the students into its equivalent grade using the Performance Indicators Rubrics adapted from BukSU-SSL (DepEd Order No. 8 s, 2015) as measurements on the learning competencies. The table below was utilized to interpret the scores and classify the level of competency of the participants.

Table 1. *Classification of the Level of Competence and its Interpretation*

Grading Scale	Descriptor	Interpretation
90-100	Outstanding	The student has an outstanding performance in all key learning domains: Knowledge, Skills and Affective.

85-89	Very Satisfactory	The student has a very satisfactory performance in all key learning domains and acquired and developed the basic knowledge and skills and able to have a transfer of knowledge.
80-84	Satisfactory	The student has a satisfactory performance in all the key learning domains and developed the fundamental knowledge and skills and core understanding of the topic.
75-79	Fairly Satisfactory	The student has an unsatisfactory performance in the key learning areas possesses the minimum knowledge and skills and core understandings but needs assistance and remediation.
Below 75	Did Not Meet Expectations	The student at this level has the difficulty with his/her understanding concepts and has never acquired the basic skills and competencies needed.

Since this study followed a descriptive research design, the comparison of the two mean scores in the pre-test and post-test was conducted using a paired t-test to identify its significant difference. Meanwhile, the data gathered from the open-ended survey questions in Ed Puzzle served as a source for the students' views about using micro-lectures via ED Puzzle. Thematic analysis was used to analyze and interpret the data.

DISCUSSION OF RESULTS AND REFLECTION

This chapter discusses the data gathered during the implementation of the study.

Table 2. *Students' Level of Competence on Differentiation Rules Before and After viewing Micro-lectures via ED Puzzle*

	Mean Score	Grade Equivalent	Descriptor	% Difference
Pre-test	11.2	55	Did Not Meet Expectations	54.46%
Posttest	17.3	85	Very Satisfactory	

The table above prevails the students' level of competence on differentiation rules before and after viewing micro-lectures via ED Puzzle. It is observed that before the students view the micro-lectures via ED Puzzle their level of competence is did not meet expectations. However, after the students viewed the micro-lectures via ED Puzzle their level of competence changed to very satisfactory. Moreover, there is a percent difference of 54.46% on their mean score in pre-test and posttest. Therefore, it indicates that their level of competence on the differentiation rules has improved after viewing the micro-lectures via ED Puzzle.

This result is correlated on several studies' findings that micro-lecture enhances students' understanding on calculus (Oktaviyanthi & Herman,2016; Kinnari-Korpela 2015) at the same time ED Puzzle can improve students' concept mastery and effective on online asynchronous learning (Giyanto et al.,2020). Moreover, according to studies done by Lewis (2019) that video, narrative, and presentation slide stimulation has an essential role in developing students' metacognition abilities. Therefore, the combination of micro-lecture and interactive educational platform is effective in improving the achievement of learning competencies in differentiation rules in an asynchronous online learning.

Table 3. *Significant difference between the students' level of competence on Differentiation Rules before and after using micro-lectures via ED Puzzle*

	Paired Differences					t	df	Sig. (2-tailed)	Interpretation
	Mean	SD	SEM	95% Confidence Interval of the Difference					
				Lower	Upper				
Pretest - Posttest	-6.1	4.483	1.002	-8.198	-4.002	-6.086	19	.000	Significant

Reflected on the table above is the statistical significance between the students' level of competence on differentiation rules before and after using micro-lectures via ED Puzzle. It revealed that it obtained a p-value less than 0.05, hence the null hypothesis is rejected. Moreover, this implies that there is sufficient evidence that there is a significant difference between the students' level of competence on differentiation rules before and after using micro-lectures via ED Puzzle.

This result suggests that the micro-lectures helped in the students' conceptual understanding of differentiation rules as indicated by the increase in their test scores. This is in lined with the studies that proved that it has a positive effect on students' achievement of learning competencies (Sweet, 2014; Song, 2016; Cai, Li & Li, 2016).

Students' Learning Experience in Using Micro-Lecture via ED Puzzle

Table 4. *Thematic Analysis on the Students' Learning Experiences on Using Micro Lecture via ED Puzzle*

Significant Statement	Code	Theme
It is informative and executed good teaching which helps to better understand the differentiation rules.	Informative and executed good teaching	Micro-lectures are content-rich.
The delivery is fun, engaging, and easy to follow with a follow up open-ended questions.	Fun, engaging, and easy to follow	High learning engagement
Provide enough time to study the lecture.	Enough time	Flexibility in learning
Provides new learning delivery that suits for self-paced learning.	New learning delivery	New learning experience

The result of the analysis as shown on the table above yielded some interesting findings. The major theme that emerged were content-rich micro-lectures, high learning engagement, provides flexibility in learning, and opens new learning experience.

a. The micro-lecture is content-rich.

The students acknowledged that the learning material is informative and executed good teaching that helped them in understanding the lesson way better about differentiation rules despite of its level of difficulty. This supports the theory that working memory capacity is limited and that processing too much information at once overwhelms it. Aside from that, the presentation is streamlined by including exact contents that are thought necessary. This follows the structure established by Mayer and Moreno (1998, 2003).

b. It provides high learning engagement.

Students claimed that they found it fun and engaging. The follow-up open-ended and multiple-choice questions allow them to reflect on their learning and raise their questions real-time. Moreover, seeing the teacher gave the lecture a more personalized ambiance, wherein they had the impression that the teacher was actually talking to them. As a result, they were more attentive and engaged in the discussion. Furthermore, this is consistent with research that shows instructor-created videos boost student engagement and perceived value of the subject (Draus, Curran & Trempus, 2014).

c. It provides flexibility in learning.

The videos' short runtime allowed the students to do repeated viewing and the segmentation of the lessons allowed intervals between times of learning. The six (6) micro-lectures were watched by the students in a time span of three weeks. Within this period, students were given the freedom when and how they want to watch. This type of learning setup appealed to the students because it did not put so much pressure on them to complete the required tasks and it also gave them the liberty to concentrate on one micro-lecture to develop mastery before moving to the next. This corroborates on the findings of Webster et al (2021) that this kind of learning delivery aided mathematical learning of the student in this current situation.

d. It provides a new learning experience.

Students viewed micro-lecture via ED Puzzle as a new learning delivery experience that they like because it helped them learn on their own pace. In like manner, Alvarez (2020) inferred that video-based interaction tools in asynchronous classes allow instructors to connect with students when they are learning alone, adding value to their own or others' visual content. Meanwhile, Cui (2020) accentuated that the integration of micro lecture enhances students' interest in learning and improve students' ability of mathematical communication and reflection. In addition, this strengthens the claim of Kuckian et al., (2022) that ED Puzzle has an important role in self-regulated skills of students. Hence, meaningful learning is achieved even on a self-pace learning mode.

Based on the findings, teachers are encouraged to explore varied mode of learning delivery to improve the achievement of learning competencies in mathematics in an asynchronous online learning. Teachers should always consider the learning needs of the students in the current learning environment. Moreover, the result of this study encouraged teachers to try using micro-lecture via ED Puzzle in delivering the lessons in an asynchronous class not just in mathematics but also on the other subjects. ED Puzzle helped to improve teaching efficiency in an online asynchronous class (Cui, 2020). Therefore, the integration of technology plus the innovative mindset of the teacher promises a positive impact towards the teaching and learning experience amidst the pandemic.

CONCLUSION

This research study utilized micro-lectures delivered through ED Puzzle to address the challenge of students' achievement of learning competencies in self-paced, asynchronous online learning. The study employed an action research design and mixed-method investigation to determine the effectiveness of this approach in improving students' achievement of learning competencies in Mathematics. The results revealed that watching micro-lectures significantly improved the students' competence level, as demonstrated by a shift from "did not meet expectations" to "very satisfactory" in the differentiation rules. The data from open-ended survey questions highlighted positive experiences such as content-rich micro-lectures, high learning engagement, flexibility in learning, and new learning delivery experiences. Therefore, the findings suggest that teachers should explore diverse modes of learning delivery, incorporating technology and thoughtful pedagogies, to enhance the teaching and learning experience, particularly in the context of asynchronous online learning during the pandemic.

RECOMMENDATION

Based on the findings of this research study, it is recommended that teachers may embrace and integrate varied modes of learning delivery, particularly in the context of asynchronous online learning, to enhance students' achievement of learning competencies in Mathematics. The use of micro-lectures via ED Puzzle proved effective in improving students' competence levels, as evidenced by the significant shift from "did not meet expectations" to "very satisfactory" in the differentiation rules. The positive experiences reported by students, including content-rich micro-lectures, high learning engagement, flexibility in learning, and novel learning delivery experiences, further support the integration of technology with thoughtful discourse and pedagogies.

Therefore, teachers may prioritize the learners' needs in asynchronous online learning and leverage technology as a valuable tool to create a positive impact on the teaching and learning experience amidst the ongoing pandemic. By adopting innovative approaches, educators can better support students in achieving their learning goals in Mathematics and beyond.

REFERENCES

i. Alvarez, C. (2021). Video technologies for professor-student interaction in online teaching. *3rd International Conference on Teaching, Learning and Education.* https://doi.org/10.33422/3rd.ictle.2021.02.110

ii. Aranzo, R., Damicog, M., Macahito, C., Reyes, A. Tancio, K., & Luzano, J. (2023). A Case Analysis of the Strategies of Students in Learning Mathematics amidst Academic Disruption. *International Journal of Multidisciplinary Approach and Studies, 10(2),* 1-15.

iii. Bandura, A. (1971). Analysis of modeling processes. *In A. Bandura (Ed.), Psychological modeling: Conflicting theories* (pp. 1-62). Chicago, IL: Aldine-Atherton. Cai, M., Li, D., & Li, X. (2016). Application Research of "Micro Lecture" Based on "Shadow Teaching". *International Journal of Information and Education Technology, 6(12),* 976-979. https://doi.org/10.7763/ijiet.2016.v6.828

iv. Cui, J. (2020). Application of Microlecture in Advanced Mathematics Teaching. *Proceedings of the 2020 6th International Conference on Social Science and Higher Education (ICSSHE 2020),* 978-94-6239-300-4. https://doi.org/10.2991/assehr.k.201214.060

v. Casanova, E., Octaviano, D., Okit, R., Tactacon, J., Arcaya, J. & Luzano, J. (2023). Enhancing Academic Performance via Web-Based Learning Material Development in Mathematics. *International Journal of Arts, Humanities and Management Studies, 9 (5),* 1-11.

vi. DepEd Order No. 12 s. 2020. (2020, June 19). https://www.deped.gov.ph/wp content/uploads/2020/06/DO_s2020_012.pdf

vii. Draus, P., Curran, M., & Trempus, M. (2014). The Influence of Instructor-Generated Video Content on Student Satisfaction with and Engagement in Asynchronous Online Classes. *MERLOT Journal of Online Learning and Teaching, 10(2),* 240-254.

viii. Francisco, L. & Prudente, M.(2021). Improving Students' Concepts and Confidence Level in Learning Photosynthesis Through 3-Minute Micro-Lectures. *Congress Proceedings on 5th International Congress on Action Research, Action Learning, ARAL 2021 pp. 370-385,* ISSN 2423-2130.

ix. Fry, M. R. (n.d.). Best Practices for Using Video in Online Learning. Retrieved April 1, 2020, from https://topkit.org/developing/tools-techniques-strategies/best practices-for-using-video-inonline-learning/

x. Giyanto, Heliawaty, L., & Rubini, B. (2020). The effectiveness of online learning by EdPuzzle in polymer materials on students' problem-solving skills. *IOP Conference Series: Materials Science and Engineering, Volume 959, Issue 1, pp. 012006.* https://doi.org/10.1088/1757-899X/959/1/012006

xi. Huang, H. M. & Witz, K. (2011). Developing children's conceptual understanding of area measurement: A curriculum and teaching experiment. *Learning and Instruction, 21,* 1-13.

xii. Kay, R. (2012). Exploring the use of video podcasts in education: A comprehensive review of the literature. *Computers in Human Behavior, 28,* 820-831. https://doi.org/10.1016/j.chb.2012.01.011.

xiii. Kinnari-Korpela, H. Using short video lectures to enhance mathematics learning experiences on differential and integral calculus course for engineering students. *Inform. Educ. 2015, 14,* 69–83. https://doi.org/10.15388/infedu.2015.05

xiv. Kizilcec, R. F., Bailenson, J. N., & Gomez, C. J. (2015). The instructor's face in video instruction: Evidence from two large-scale field studies. *Journal of Educational Psychology, 107(3),* 724–739. https://doi.org/10.1037/edu0000013

xv. Kuckian, S., Adams,J., & Anil, V. (2022). Utilization of ED Puzzle: An interactive tool in teaching practices. *International Journal of Special Education. 37.* 2022-1633.

xvi. Lewis, H.(2019).Supporting the development of young children's metacognition through the use of video-stimulated reflective dialogue. *Early Child Development and Care* 189 1842-1858. https://doi.org/10.1080/03004430.2017.1417273

xvii. Linog, B., Lahoylahoy, M., & Alguno, A. (2013). PhET Simulation-aided lessons and demonstrations: approach to enrich students' understanding on the least-learned competency in Physics education. *Proceedings of International Journal of the Computer, the Internet and Management Col. 21* pp 46-50.

xviii. Liu, X., & Wang, L. (2013). The Analysis on Systematic Development of College Microlecture. *Higher Education Studies, 3(6).* https://doi.org/ 10.5539/hes.v3n6p65

xix. Luzano, J. F. (2020). Development and Validation of Strategic Intervention Materials (SIMs) of the Selected Topics in Trigonometry of Precalculus Discipline in Senior High School. *Journal of Mathematics and Statistics Studies, 1(2),* 26–37.

xx. Luzano, J. & Ubalde, M. (2023). Notable Accounts of the Professional Practice of Tertiary Mathematics Teachers in the Philippines. *Science International (Lahore), 35(2)*, 129-133.

xxi. Luzano, J. (2023). The Interplay of Conceptual Understanding and Problem-Solving Competence in Mathematics. *International Journal of Multidisciplinary Approach and Studies, 10(2),* 89-97.

xxii. Mayer, R. E. (2014). Cognitive theory of multimedia learning. In R. E. Mayer (Ed.), Cambridge handbooks in psychology. *The Cambridge handbook of multimedia learning* (p. 43–71). Cambridge University Press. https://doi.org/10.1017/CBO9781139547369.005

xxiii. Mayer, R.E., & Moreno, R. (1998). *A Cognitive Theory of Multimedia Learning: Implications for Design Principles.* CHI 1998. Retrieved February 26, 2022, from https://www.researchgate.net/publication/248528255.ACognitive_Theor y_of_M ultimedia_Learning_Implications_for_Design_Principles

xxiv. Mayer, R. E., & Moreno, R. (2003). Nine Ways to Reduce Cognitive Load in Multimedia Learning. *Educational Psychologist, 38(1)*, 43-52. https://doi.org/ 10.1207/s15326985ep3801_6

xxv. Mocon-Ciriaco, C. (2019, December 6). Deped vows to improve quality of education after PISA showing. *CNN Philippines.* https://businessmirror.com.ph/2019/12/06/depedvows-to-improve quality-of-education-after-pisa-showin

xxvi. Oktaviyanthi, R., & Herman, T. (2016). A delivery mode study: The effect of self-paced video learning on first-year college students' achievement in calculus. *AIP Conf. Proc. 2016, 1782,* 050012. https://doi.org/10.1063/1.4966102

xxvii. Pang-an, A., Arceno, J., Tantog, A. Alayon, M., & Luzano, J. (2022). Learning Experiences of College Students in Mathematics in the Modern World during Synchronous Classes. *International Journal of Academic Multidisciplinary Research, 6(10),* 89-97.

xxviii. Peng, Y. (2019). Application of Micro-lecture in Computer Teaching. *IOP Conference Series: Earth Environmental Science*, *Volume 234, 012053.* https://doi.org/10.1088/1755-1315/234/1/012053

xxix. Russo, T., & Benson, S. (2005). Learning with Invisible Others: Perceptions of Online Presence and their Relationship to Cognitive and Affective Learning. *Educational Technology and Society, 8(1)*, 54-62.

xxx. Seethaler, S., Burgasser, A. J., Bussey, T. J., Eggers, J., Lo, S. M., Rabin, J. M., Weizman, H. (2020). A Research-Based Checklist for Development and Critique of STEM Instructional Videos. *Journal of College Science Teaching, 50(1).*

xxxi. Song, Y. (2016). The Application of Microlecture in College English Teaching Process in China. *Open Access Library Journal, 03*, 1-6.

xxxii. Sweet, D. (2014). Micro-lectures in a Flipped Classroom: Application, Creation and Resources. Mid-Western Educational Researcher, 26, 52-59. https://eric.ed.gov/?id=EJ1025664

xxxiii. Sweller, J. (2003). Evolution of human cognitive architecture. *Psychology of Learning and Motivation Psychology of Learning and Motivation Volume 43,* 215-266. https://doi.org/10.1016/s0079-7421(03)01015-6

xxxiv. Webster, M., Delanoy, N., and Brown, B. (2021). Flipped Learning in Junior High Math Classes: Almadina Language Charter Academy (Research Brief). University of Calgary, Calgary, AB. http://hdl.handle.net/1880/114091 report

xxxv. Wei, D. D., Qiu, L. X., & Yu, H. (2017). Research on design and development of high quality micro-lecture resources. *2017 12th International Conference on Computer Science and Education (ICCSE).* https://doi.org/10.1109/iccse.2017.8085570

xxxvi. Wijaya, T.T., Cao, Y., Weinhandl, R., Yusron, E., & Lavicza, Z. (2022). Applying the UTAUT Model to Understand Factors Affecting Micro-Lecture Usage by Mathematics Teachers in China. *Mathematics 2022, 10,* 1008. https://doi.org/10.3390/ math10071008

xxxvii. Yang, Y., Zhang, X., & Tian, D. (2016). Analysis on Micro-lecture Design in Modern Distance Education. *Proceedings of the 2016 2nd International Conference on Economics, Management Engineering and Education Technology (ICEMEET 2016).* https://doi.org/10.2991/icemeet-16.2017.79