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Effects of Asynchronous Modality of Learning on Students' Achievement in Learning Mathematics among Grade 9 Students

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Abstract:-

Background/Objectives: In hurdling the fast-changing educational system, especially in the midst of Covid-19, teachers should be more familiar with technological advancements that can easily personalize their asynchronous learning materials to accommodate different learning styles. This study investigates the effect of an asynchronous learning modality on students' achievement in learning Grade 9 Mathematics.

Methods/Statistical analysis: The research design is descriptive and quasi-experimental. A convenience sampling technique was adopted. Pre-test and post-test were administered to 277 Grade 9 students in Zambales National High School.

Findings: Study findings revealed that the students performed fairly satisfactorily using the asynchronous platform during the pre-test while achieving satisfactory ratings on the post-test. There was a significant difference in student achievement between pre-test and post-test on quadratic equations using the asynchronous platform. The respondents agreed on the effects of an asynchronous learning modality using DepEd TV. Mathematics intervention program has been developed based on respondents' appraisal of the use of DepEd TV as a tool for asynchronous learning modality.

Improvements/Applications: These findings imply the need to utilize locally produced video lessons as valid intervention material in teaching Mathematics.

Keywords: asynchronous modality, student achievement, mathematics, DepEd TV

1. Introduction

The basis of science and technology is arithmetic and logical reasoning, regarded as the main competency in learning mathematics. As such, educational authorities emphasize students' computational skills and problem-solving proficiency.

An asynchronous mode of learning/teaching has been the most prevalent form of online teaching so far because of its flexible modus operandi [1]. Asynchronous

environments provide students with readily available material in the form of audio/video lectures, handouts, articles and PowerPoint presentations. This material is accessible anytime, anywhere via Learning Management System (LMS) or other channels. LMS is a set of tools that houses course content and provides a framework for communication between students and teachers like a classroom. Other terms sometimes used instead of LMS are Course Management System (CMS) and Virtual Learning Environment (VLE). CMS is comparatively an older term, and its usage is less common today as it implies basic management of course content. At the same time, LMS indicates the system that supports the learning process. The term VLE also implies the support of the learning process, but it is more frequently used to describe systems that support blended learning environment [2].

DepEd announced the initialization of educational classes through blended learning during the Covid-19 pandemic in the Philippines. Among many options is to broadcast learning modules on television and radio. The department later tapped the state media agency Presidential Communications Operations Office (PCOO) to assist in producing and airing lessons and modules.

A large portion of remote education is asynchronous distance learning. It includes any lesson in which the educator instructs at a time when the learner is not present, such as many pre-recorded e-learning platforms. Asynchronous learning provides convenience and flexibility. Learning at your own pace is one of the most appealing advantages of asynchronous learning. This is made possible by a wide range of digital teaching tools that rely on online modules that can be accessed from your home computer at any time. So, if the teacher uploads an assignment on any given day, you can log in and finish the module at your leisure and your own pace, as long as it is completed by the due date. The option to adjust the speed and tempo with which you complete a course provides you with more freedom while also increasing your responsibility. In contrast to traditional classrooms, students in asynchronous learning have more control over their class schedules. This opens more chances for students who may be unable to attend a typical class due to other obligations. Asynchronous learning is more practical than synchronous learning because it gives students more control over their learning. Imagine being able to keep your part-time job while attending college or being able to enrol in a program that would otherwise be too far away. Additionally, asynchronous learning can save you not only time but also money. For example, because you are not obliged to travel, you can save money on essential travel expenditures or school supplies. The same may be said for teaching or learning materials, as well as the physical teaching environment. Furthermore, institutional savings are frequently passed on to digital learners [3].

Asynchronous means self-paced, which means participants can use asynchronous learning features like online audio and video, DepEd TV, and discussion forums whenever and whenever they want. Synchronous means forcing participants and instructors/facilitators to digitally convene at the same time from different locations in real time. Webinar technologies, such as Zoom, and virtual classrooms, such as Adobe Connect, are two of the most popular tools for synchronous learning [4]. Studies shows that there is a close relation between asynchronous and synchronous modality of learning. However, asynchronous has different goals and perspectives on how to learn using DepEd TV as platform method associated with the most essential learning competencies on quadratic equations in terms of extracting roots, factoring, completing the square, quadratic formula, discriminant, rational algebraic equations and problem-solving. Therefore, to narrow this gap as it can affect the quality of learning, it is important to consider the subject matter/learning competencies, their learning skills on how to use the DepEd TV features, and even their perception regarding the usage of DepEd TV.

DepEd TV gives a platform for students to express their various learning styles. The episodes were created with additional interactive elements to keep learners' attention and help them achieve the desired competencies.

Given that stand, few studies investigate the effects of asynchronous learning modality among students and document their perception using DepEd TV, thus this study.

The rest of the paper is organized as follows, i.e., Section 2 states the Objectives of the Study, Section 3 presents the Hypothesis, Section 4 discusses the Methodology, Section 5 pinpoints the Results and Discussion and finally, Section 6 concludes the summary of the research work with statement of future scope.

2. Objectives of the Study

The specific objectives of this study were to determine the performance of students using asynchronous platform on their pre-test associated with the most essential learning competencies on quadratic equations; determine their performance on post-test; test difference on students' Mathematics achievement based on compared results of pre-test and post-test scores using asynchronous modality as intervention; describe the degree of agreement of student assessment on the effects of asynchronous modality, and propose a program based on the assessment on the effects of asynchronous modality to students.

3. Hypothesis

In this study, the following hypotheses were tested:
(1) There is no significant difference in students'

Mathematics achievement based on the compared result of pre-test and post-test scores using asynchronous modality as intervention.

4. Methodology

This study employed a descriptive and quasi-experimental research design. Both designs used a quantitative approach.

A quasi-experimental design was used to measure the performance of the students in Mathematics using the asynchronous online platform. A quasi-experimental design, like a true experiment, tries to prove a cause-and-effect link between an independent and dependent variable. Unlike a true experiment, a quasi-experiment does not rely on random assignment. Subjects are instead divided into groups depending on non-random factors. In circumstances where true experiments are not possible due to ethical or practical considerations, quasi-experimental design is a helpful technique [5]. The main objective of experimental research design is to provide more definitive conclusions about the causal relationships among the variables in the research hypothesis than correlational designs. The research hypothesis suggests that the manipulated independent variables cause changes in the measured dependent variables.

The lessons in Grade 9 Mathematics competencies focus on illustrating quadratic equations, solving quadratic equations by a) extracting roots, b) factoring, c) completing the square, and d) using the quadratic formula, characterizing the roots of a quadratic equation using the discriminant, describe the relationship between the coefficients and roots of a quadratic equation, solve equation transformable to quadratics (including rational algebraic equations, solve problems involving quadratic equations and rational algebraic equations.

The study involved two hundred seventy-seven (277) student-respondents of the Grade 9 from Zambales National High School officially enrolled in Mathematics subject during the first grading period of the school year 2021-2022.

The pretest-posttest teacher-made test was used as the main instrument to determine the effects of the asynchronous modality of learning on students' performance in Zambales National High School. It has the 35-item supply-answer type of test questions consisting of 15 - item easy, 10 – item average, and 10 – item difficult questions. The pre-test and post-test questions which the researchers prepared are submitted to experts to check on the validity of the questions. It was validated by the Master Teachers and Head Teacher of the Mathematics Department. To test the validity, the researcher conducted a pilot-testing of the instrument for all Grade 9 Zambales National High School students who are not part of the study. During the pilot testing, the researchers noted observations on the allocation of time for the test. The Cronbach alpha was used to establish the internal consistency of an instrument. The research question items on pre-test and post-test measures have relatively high internal consistency since the alpha coefficient of the items was 0.885. After the questionnaires were evaluated, the researchers included all the ideas and corrections ready for administration to the respondent-students and confirmed to have a high-reliability coefficient.

The researchers employed convenience sampling as a sample technique. Convenience sampling is a non-probability sampling technique that involves selecting research sample based on convenience and accessibility. The researchers resort to collecting data from the most accessible variables in the population. There are three primary reasons why a researcher would opt for convenience sampling population size, timeframe, and accessibility.

The researchers administered a pre-test to determine the respondent's prior knowledge for some competencies on the following topics: extracting roots, factoring, completing the square, quadratic formula, discriminant, rational algebraic equations, and problem-solving. After administering the pre-test to the target respondents, a 20-day experiment will start. On the first day of the experiment, the researchers gave and sent printed and digital modules/learning activity sheets to the respondents via group chat/schedule. Aside from that, the researchers also uploaded recorded video lessons per competency anchored from DepEd TV with complete learning activity guide weekly. The respondents needed to watch the video lessons independently to understand better the concepts given by the teacher. Repeat the process until the last day of experiment is completed. Formative and summative assessments will follow to assess students' understanding of that particular topics/competency. At the end of the session, the students gave their feedback regarding the asynchronous online platform.

The study utilized the interrelation of the Independent Variable and Dependent Variable (IV-DV) Model.

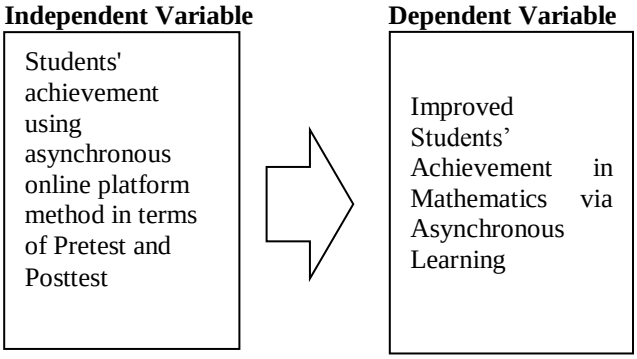

Figure 1. The Paradigm of the Study

The first box consists of the independent variables, which include the students' performance using the asynchronous online platform method in terms of pre-test and post-test. A significant aspect of successful online learning programs is DepEd TV. It refers to a student's ability to obtain material on their own time, demonstrate what they have learned, and communicate with classmates and teachers. They do not have to participate in the same room or even in the same time zone. DepEd TV as a learning modality emphasizes flexibility and self-paced learning. Asynchronous learning gives all students more flexibility and fits a variety of learning methods.

The improved performance in Mathematics via asynchronous learning is the study's dependent variable presented in the second box. Student achievement refers to how much academic knowledge a student learns in a given length of time. Educators must teach certain criteria or goals to their pupils at each level of education. Regular progress and comprehension checks and tests are frequently used to assess achievement in terms of extracting roots, factoring, completing the square, quadratic formula, discriminant, rational algebraic equation and problem-solving.

This study is anchored on Moore's theory of Transactional Distance. In his Theory of Transactional Remote, Michael G. Moore claims that in distance learning scenarios, the teacher-student separation might lead to communication gaps, a psychological area of potential misunderstandings between instructors' and learners' behaviors [6].

Three variables must be considered like the transaction created between professors and students in distant learning: conversation, structure, and learner autonomy. Dialogue encompasses more than two-way communication; it encompasses all forms of contact "within the context of clearly stated educational aims, teacher cooperation and understanding, and, ultimately, it culminates in solving the learners' problems [7].

Moore's theory claims that these three elements have an inverse connection, with increases in one leading to commensurate drops in the others [8]. For example, a rigid framework in a course might reduce the quality of interaction and the sense of learner autonomy, raising the students' perception of transactional distance. Moore (1997), on the other hand, observes that when course structure falls below a certain threshold (which he does not specify), the perception of transactional distance might rise, owing to the possibility of learner misunderstanding or discontent [7].

To ensure continuity of learning, DepEd Order No 12, s. 2020 entitled, " Adoption of the Basic Education Learning Continuity Plan for School Year 2020-2021 in Light of the covid 19 Public Health Emergency," stipulates learning continuity through K to 12 curriculum adjustments, alignment of learning materials, deployment of multiple learning delivery modalities, provision of corresponding training for teachers and school leaders, and proper orientation of parents or guardians as facilitators of learning as the learning environment is transferred from school to home.

As the major highlight of the new normal in education, the school shall continue
to provide Self-Learning Materials and resources to learners as well as the provision of digitized materials aligned with the Essential Learning Competencies (MELC).

Offices of the Undersecretaries for Administration, Curriculum and Instruction, and field Operations strongly emphasize the need to maximize the use of DepEd TV as part of the learning delivery modalities under the basic Education Learning Continuity Plan (BE-LCP). The DepEd TV episodes may be combined with other modalities of instruction to ensure that each competency/lesson that our learners must attain for the entire school is delivered and understood. The education department has launched DepEd TV —a program that converts self-learning modules into video lessons that can be accessed through IBC13 and Solar Learning Outlets. It features "teacher-broadcasters" who underwent training on how to deliver lessons via pre-recorded videos effectively. Regional Offices are also instructed to enhance the implementation of the Basic Education-Learning Continuity Plan (BE-LCP), including maximizing the use of DepEd TV and Radio-Based Instruction to lessen reliance on printed modules, encourage return of learners who did not enroll last year, and ensure the equitable distribution of teachers' workload following the standards set in Magna Carta for Teachers.

Cognitive Theory of Multimedia Learning, deeper learning is possible. When information is presented in both text and graphics, it is more likely to occur than if it is offered solely in text. The concept of Multimedia Learning is based on the assumption that there are two types of learning channels: auditory and visual. Both of these channels are utilized to store data in working memory. This theory is based on cognitive load and information processing theories. The workload on the mind occurs when extraneous information exceeds the working memory's processing capability [9].

According to information processing theory, new information passes through a sequence of stages in human memory, allowing it to be stored in long-term memory. Multimedia learning theory is founded on the premise that when using multimedia, it is critical to lower cognitive load and, as a result, improve our memory's ability to comprehend information. A fundamental difficulty for instructional designers is that meaningful learning can necessitate a large amount of critical cognitive processing while the learner's information processing system's cognitive resources are severely limited. As a result, multimedia training should be designed in such a way that any superfluous cognitive load is reduced [10].

5. Results and Discussion

Achievement of Students Using Asynchronous Platform during Pre-test on Quadratic Equations

Table 1. Extracting Roots (Pre-test)

Descriptive Value	Numerical Rating	Frequency	Percent
Outstanding	90-100	29	10.47
Very Satisfactory	85-89	22	7.94
Satisfactory	80-84	61	22.02
Fairly Satisfactory	75-79	119	42.96
Did not meet expectation	60-74	46	16.61
Total		**277**	**100.00**
Mean		**79.12**	
		Fairly Satisfactory	

Out of 277 student-respondents, there were 119 or 42.96% had fairly satisfactory achievement ranging from 75-79; 46 or 16.61% obtained an achievement ranging from 60-74; 61 or 22.02% obtained an achievement ranging from 80-84; 29 or 10.47% obtained an achievement ranging from 90-100; and 22 or 7.94% of the students obtained an achievement ranging from 85-89 described as very satisfactory.

The computed mean score of the students using asynchronous online platform method during pre-test on quadratic equations in terms of extracting roots was 79.12 and interpreted as Fairly Satisfactory. This result means that the achievement of the Grade 9 students using asynchronous online platform method during pre-test on quadratic equations in terms of extracting roots, the child's learning has not been solid even though they have been taught basic skills on how to extract roots as a part of competency in Grade 7. From the researcher's points of view that the student-respondents did not show interest on that topic/competency. They may not see the significance of extracting roots as a competency in their daily living.

This finding corresponds to the study conducted by Baer & Vargas (2021) who found out that pre-test scores of the control group has a mean of 19.54 (Sd=6.171) while the experimental group reported a mean score of 18.45 (sd=6.577) which is a little higher. The variance results of 6.171 and 6.577 of their study are not that big which signifies that both classes are heterogeneous; meaning the learners were of the same level of intelligence. This is indeed a good baseline since the results suggest that the two sections included in the study are almost the same in the manner that the scores are scattered. This means that the learner's grouping is mixed as to their abilities [11]. The findings are consistent with Peteros, Gamboa, Etcuban, Dinauanan, Sitoy & Arcadia (2020) which found that problems about learning the subject need to be addressed to improve students' performance, mainly that they were already assessed for the three grading periods, yet their performance needs to be improved. The majority of the respondents had reasonably satisfactory performance, which is not a good sign when it comes to the teaching-learning process. This implies that students learned from the subject at a minimal level [12].

Table 2. Factoring (Pre-test)

Descriptive Value	Numerical Rating	Frequency	Percent
Outstanding	90-100	0	0.00
Very Satisfactory	85-89	38	13.72
Satisfactory	80-84	80	28.88
Fairly Satisfactory	75-79	53	19.13
Did not meet the expectation	60-74	106	38.27
Total		**277**	**100.00**
Mean		**83.31**	
		Satisfactory	

Out of 277 student-respondents, there were 106 or 38.27% did not meet expectations achievement ranging from 60-74; 80 or 28.88% obtained an achievement ranging from 80-84; 53 or 19.13% obtained an achievement ranging from 75 -79; and 38 or 13.72% of the students had very satisfactory performance ranging from 85 - 89. The computed mean score of the Grade 9 students using asynchronous online platform method during pre-test on quadratic equations in terms factoring was 83.31 interpreted as Satisfactory. This result indicates that the pre-test achievement of the students during pre-test on quadratic equations in terms of factoring was Satisfactory which denotes that the students perform quite well in quadratic equations in terms of factoring using asynchronous online platform.

Based on the researcher's observation and students 'perspectives that factoring process will require four major steps to solve the equation. The first step is moving all terms to one side of the equation, usually the left, using addition or subtraction. Second, factor the equation completely. Third, set each factor equal to zero, and solve. Last, let the students list each solution from step 3 as a solution to the original equation. This process is complicated, but the students did the good job described as satisfactory in their pretest.

The results showed conformity with the study of Peteros, et al. (2020) that the low level of the respondents' self-concept could be based on their experiences that they were unable to solve severe mathematics problems and that

they think that not all these problems have answers. On the other hand, students still believe that they can learn Mathematics quickly based on the weighted mean of their responses in item 1 which is 2.97 with a standard deviation of 0.791 in the same way that they think that learning Mathematics gives meaning to their activities. Students find the meaning of their task in the subject, which helps them realize the need to learn the subject [12]. The study of Seaton, Parker, Marsh, Craven & Yeung (2014) suggests that motivated students and those with high academic self-concepts perform better academically. Although substantial evidence supports a reciprocal relationship between academic self-concept and achievement, there is less evidence supporting a similar relation between achievement goal orientations and achievement [13].

Table 3. Completing the Square (Pre-test)

Descriptive Value	Numerical Rating	Frequency	Percent
Outstanding	90-100	4	1.44
Very Satisfactory	85-89	11	3.97
Satisfactory	80-84	41	14.80
Fairly Satisfactory	75-79	70	25.27
Did not meet expectation	60-74	151	54.51
Total		**277**	**100.00**
Mean		**72.95**	
		Did not meet expectation	

Out of 277 student-respondents, there were 151 or 54.51% whose achievement are ranging from 60-74 interpreted as did not meet expectation; 70 or 25.27% obtained an achievement ranging from 75-79; 41 or 14.80% obtained an achievement ranging from 80-84; 11 or 3.97% obtained an achievement ranging from 85-89; and 4 or 1.44% of the Grade 9 students obtained an achievement ranging from 90-100 described as outstanding. The computed mean score of the Grade 9 students using asynchronous online platform method during pre-test on quadratic equations in terms completing the square was 72.95 and interpreted as Did not meet expectation. This result indicates that the pre-test achievement of the students during pre-test on quadratic equations in terms of completing the square was very poor which implies that the students found their pre – test in quadratic equations in terms of completing the square using asynchronous online platform was not easy to solve for them to obtain an achievement of did not meet the expectation.

Based on the researcher's observation and students 'perspectives, some quadratic equations cannot be readily factored and are not given in a format that allows the students to use the square root property immediately. However, they can use a technique called completing the square to rewrite the quadratic expression as a perfect square trinomial. Then, students can factor the trinomial and solve the equation using the square root property. This competency is complicated that needs concentration.

According to O'Connor & Norton (2016), geometric models are useful in adding understanding in developing the quadratic formula via completing the square procedure [14].

Table 4. Quadratic Formula (Pre-test)

Descriptive Value	Numerical Rating	Frequency	Percent
Outstanding	90-100	0	0.00
Very Satisfactory	85-89	20	7.22
Satisfactory	80-84	71	25.63
Fairly Satisfactory	75-79	48	17.33
Did not meet expectation	60-74	138	49.82
Total		**277**	**100.00**
Mean		**81.73**	
		Satisfactory	

Out of 277 student-respondents, there were 138 or 49.82% did not meet expectation achievement ranging from 60-74; 71 or 25.63% obtained an achievement ranging from 80-84; 48 or 17.33% obtained an achievement ranging from 75-79; and 20 or 7.22% of the students obtained an achievement ranging from 85-89 described as very satisfactory. The computed mean score of the Grade 9 students using asynchronous online platform method during pre-test on quadratic equations in terms quadratic formula was 81.73 interpreted as Satisfactory. This result indicates that the pre-test achievement of the students during pre-test on quadratic equations in terms of quadratic formula was satisfactory which connotes that the student's achievement was average in quadratic equations in terms of quadratic formula using asynchronous online platform.

Based on the researcher's observation and students 'perspectives that to solve quadratic equation using the quadratic formula, the students need to write the quadratic equation in standard form, identify the values of a, b, and c. Then substitute the values of a, b, and into quadratic formula, simplify, and check the solutions. The students can easily check their work by substitution.

This supported with the study of Guolin & Douglas (2016) that multimedia and simulation enhance the traditional teaching and learning without changing the basic mode of instruction. According to them, availability of various resources/materials would help provide a supportive learning environment to encourage student's statistical exploration, and thus eventually nurture an atmosphere in

which questions can be freely asked, feedback promptly provided, and support available just-in-time [5]. McDaniel & Green (2012) found that using online instructional modules, which combine an applet, audio-visual tutorials, and guided discovery questions, increased students 'understanding of sampling variability concepts [16].

Table 5. Discriminant (Pre-test)

Descriptive Value	Numerical Rating	Frequency	Percent
Outstanding	90-100	0	0.00
Very Satisfactory	85-89	24	8.66
Satisfactory	80-84	53	19.13
Fairly Satisfactory	75-79	68	24.55
Did not meet expectation	60-74	132	47.65
Total		**277**	**100.00**
Mean		**74.06**	
		Did not meet expectation	

Out of 277 student-respondents, there were 132 or 47.65% whose achievement are ranging from 60-74 interpreted as Did not meet expectation; 68 or 24.55% obtained an achievement of from 75-79; 53 or 19.13% obtained an achievement ranging from 80-84; and 24 or 8.66% of the students obtained an achievement performance ranging from 85-89. The computed mean score of Grade 9 students using asynchronous online platform method during pre-test on quadratic equations in terms discriminant was 74.06 interpreted as Did not meet the expectation. This result indicates that the pre-test achievement of the students during pre-test on quadratic equations in terms of discriminant was did not meet expectation which signifies that the students' performance has a very low achievement in quadratic equations in terms of discriminant using asynchronous online platform.

Based on the researcher's observation and students 'perspectives, the respondents need to calculate the discriminant using the formula and solve the quadratic equation, which depends on the sign of the discriminant Δ, which leads to three possible cases. This competency is complicated and needs concentration to solve the roots of quadratic equations.

This finding is contrary to the findings of Guolin, et al (2016) which analyzed the technology integration in the classroom which has the great potential to enhance statistics teaching and learning. However, turning the potential into a reality can be a complex and daunting task. Instructors need to overcome various obstacles to create rich learning environments with technology use and necessary support mechanisms [15]. The findings corroborate Ibrahim, Greenwood & Wheeler (2012) study, which found that the instructor consider his or her learners when weeding educational videos, including information that is necessary for their processing but eliminating information that they do not need to reach the learning goal and that may overload their working memory and has shown that this treatment can improve retention and transfer of new information from video [17].

Table 6. Rational Algebraic Equations (Pre-test)

Descriptive Value	Numerical Rating	Frequency	Percent
Outstanding	90-100	0	0.00
Very Satisfactory	85-89	16	5.78
Satisfactory	80-84	50	18.05
Fairly Satisfactory	75-79	62	22.38
Did not meet expectation	60-74	149	53.79
Total		**277**	**100.00**
Mean		**73.10**	
		Did not meet expectation	

Out of 277 student-respondents, there were 149 or 53.79% whose achievement ranging from 60-74 interpreted as Did not meet expectation; 62 or 22.38% obtained an achievement ranging from 75-79; 50 or 18.05% obtained an achievement ranging from 80-84; and 16 or 5.78% of the students obtained an achievement ranging from 85-89 described as very satisfactory. The computed mean score of the Grade 9 students using asynchronous online platform method during pre-test on quadratic equations in terms rational algebraic expressions was 73.10 interpreted as Did not meet the expectation. This result indicates that the pre-test achievement of the students during pre-test on quadratic equations in terms of rational algebraic expressions was Did not meet expectation which signifies that the students struggle in quadratic equations in terms of rational algebraic expressions using asynchronous online platform.

Based on researcher's observation and students 'perspectives, to simplify rational expressions requires good factoring skills. There are four steps to follow in simplifying rational algebraic expressions: factor the numerator and denominator, list restricted values, cancel common factors, and reduce to lowest terms and note any restricted values not implied by the expression. This competency is complicated and needs to capture students' interest to excel in this particular topic.

From a contemporary perspective, quadratic equations are considered important in school mathematics

curricula because they bridge mathematical topics such as linear equations, functions, and polynomials [18]. Furthermore, like linear equations, quadratic equations are powerful representations used in other disciplines, such as physics, engineering, and design, due to their usefulness in solving many kinds of word problem. Szpunar, Jing & Schacter (2013) compared the test performance of students who answered questions interpolated between ~5 min video lectures and students who did unrelated arithmetic problems between the videos, finding that the students in the interpolated question group performed significantly better on subsequent tests of the material and reported less mind wandering [19].

Table 7. Problem Solving (Pre-test)

Descriptive Value	Numerical Rating	Frequency	Percent
Outstanding	90-100	0	0.00
Very Satisfactory	85-89	7	2.53
Satisfactory	80-84	39	14.08
Fairly Satisfactory	75-79	72	25.99
Did not meet expectation	60-74	159	57.40
Total		**277**	**100.00**
Mean		**72.22**	
		Did not meet expectation	

Out of 277 student-respondents, there were 159 or 57.40% whose achievement ranging from 60-74 interpreted as Did not meet expectation; 72 or 25.99% obtained an achievement of ranging from 75-79; 39 or 14.08% obtained an achievement ranging from 80-84; and 7 or 2.53% of the students had very satisfactory achievement ranging from 85-89. The computed mean of the Grade 9 students using asynchronous online platform method during pre-test on quadratic equations in terms problem solving was 72.22 interpreted as Did not meet the expectation. This result indicates that the pre-test achievement of the students during pre-test on quadratic equations in terms of problem solving was very low, indicating that the students have difficulty in quadratic equations in terms of problem solving using asynchronous online platform.

Based on researchers' observation and students 'perspectives, respondents need to apply basic skills in solving quadratic equations. Many word problems involving unknown quantities can be translated for solving quadratic equations. There are steps and methods of solving quadratic equations: denote the unknown quantities by x,y,etc., use the conditions of the problem to establish in unknown quantities, use the equations to establish one quadratic equation in one unknown, and solve this equation to obtain the value of unknown in the set to which it belongs. This competency is the application of subtopic involving quadrating equation. It needs understanding and comprehension of the previous lessons.

In the study conducted by Guo, Kim & Robin (2014) revealed that when creating or choosing videos, it is important to consider whether they were created for the type of environment in which they will be used. For example, a face-to-face classroom session that is videotaped and presented within an online class may feel less engaging than a video that is created with an online environment as the initial target. A video's adaptability can be enhanced, however: when reusing videos, instructors can package them for a particular class using text outside the video to contextualize the relevance for that class and lesson [20].

Achievement of Students Using Asynchronous Platform during Post-test on Quadratic Equations

Table 8. Extracting Roots (Post-test)

Descriptive Value	Numerical Rating	Frequency	Percent
Outstanding	90-100	186	67.15
Very Satisfactory	85-89	7	2.53
Satisfactory	80-84	43	15.52
Fairly Satisfactory	75-79	10	3.61
Did not meet expectation	60-74	31	11.19
Total		**277**	**100.00**
Mean		**89.00**	
		Very Satisfactory	

Out of 277 student-respondents, there were 186 or 67.15% had an outstanding achievement ranging from 90-100; 7 or 2.53% obtained an achievement from 85-89; 43 or 15.52% obtained an achievement ranging from 80-84; 10 or 3.61% obtained an achievement ranging from 75-79; and 31 or 11.19% of the students obtained an achievement ranging from 60-74. The computed mean score in the post-test of Grade 9 students in quadratic equations in terms of extracting roots was 89.00 interpreted as Very Satisfactory. This result signifies that the students' achievement in quadratic equations employing asynchronous online platform method, the achievement of the Grade 9 students improved from fairly satisfactory in pre-test to very satisfactory during post-test on the aspect of quadratic equation in terms of extracting roots.

Based on the student-respondents' appraisal, the use of DepEd TV in education was an effective way to engage and support their understanding in terms of Extracting Roots as competency under quadratic equations. Deped TV has a

great impact on their studies in learning mathematics competencies.

The findings support of the study of Baer & Vargas (2021) who found that the experimental group of learners who were exposed to the video lessons obtains a mean score of 42.17 (Sd=4.751) while the control group who were taught using the traditional method obtain a mean score of 36.20 (Sd=10.105). The result showed that the post-test scores of the experimental groups taught with video lessons are remarkably better than those taught the traditional approach. Looking at the standard deviation scores, it signifies that the variance of the experimental group was smaller than that of the control group which suggests that the learners' intellectual ability was not scattered unlike in the pretest result [21].

Table 9. Factoring (Post-test)

Descriptive Value	Numerical Rating	Frequency	Percent
Outstanding	90-100	0	0.00
Very Satisfactory	85-89	197	71.12
Satisfactory	80-84	26	9.39
Fairly Satisfactory	75-79	30	10.83
Did not meet expectation	60-74	24	8.66
Total		**277**	**100.00**
Mean		**83.71**	
		Satisfactory	

Out of 277 student-respondents, there were 197 or 71.12% had very satisfactory achievement ranging from 85-89; 26 or 9.39% obtained an achievement ranging from 80-84; 30 or 10.83% obtained an achievement from 75-79; and 24 or 8.66% of the students obtained an achievement ranging from 60-74. The computed mean of the post-test of Grade 9 students in quadratic equations in terms of factoring was 83.71 interpreted as Satisfactory. This result indicates that the students' achievement in quadratic equations employing asynchronous online platform method, the achievement of the Grade 9 students in Mathematics was satisfactory in pre-test and with the use of DepEd TV as asynchronous learning modality in learning the performance of the students became satisfactory. There is a little bit improvement from pre-test to post-test results on the aspect of quadratic equation in terms of 'factoring'.

Based on the student-respondents' appraisal, the use of DepEd TV in education was an effective way to engage and support their understanding in terms of Factoring as competency under quadratic equations. Deped TV has a great impact on their studies in learning mathematics competencies.

The study of Brame & Kathryn (2016) recommended that educational videos have become an important part of higher education, providing an important content-delivery tool in many flipped, blended, and online classes. Effective use of video as an educational tool is enhanced when instructors consider three elements: how to manage cognitive load of the video; how to maximize student engagement with the video; and how to promote active learning from the video [22].

Table 10. Completing the Square (Post-test)

Descriptive Value	Numerical Rating	Frequency	Percent
Outstanding	90-100	130	46.93
Very Satisfactory	85-89	56	20.22
Satisfactory	80-84	43	15.52
Fairly Satisfactory	75-79	27	9.75
Did not meet expectation	60-74	21	7.58
Total		**277**	**100.00**
Mean		**87.49**	
		Very Satisfactory	

Out of 277 student-respondents, there were 130 or 46.93% had outstanding achievement ranging from 90-100; 56 or 20.22% obtained an achievement ranging from 85-89; 43 or 15.52% obtained a achievement ranging from 80-84; 27 or 9.75% obtained an achievement ranging from 75-79; and 21 or 7.58% of the students obtained an achievement ranging from 60-74 described as Did not meet expectation. The mean of the post-test achievement in quadratic equations in terms of completing the square was 87.49 interpreted as Very Satisfactory. This particular result implies that the students' achievement in quadratic equations using asynchronous online platform method, the achievement of the Grade 9 student's achievement improved from did not meet expectation in pre-test to very satisfactory during post-test on the aspect of quadratic equation in terms of 'completing the square.

Based on the student-respondents' appraisal, the use of DepEd TV in education was an effective way to engage and support their understanding of Completing the Square as competency under quadratic equations. Deped TV has a great impact on their studies in learning mathematics competencies.

This finding corresponds to the study conducted by Skinner, Wheatley, Knopfmeier, Reinhart, Choate, Jones & Palikonda (2018), which states that well-designed multimedia helps learners build more accurate and effective mental models than they do from text alone [23]. The findings also revealed that students enjoy attending classes

that utilize multimedia presentations because they find these classes to be more interesting and exciting. According to Jain, Kumar, Mandal, Ong, Poutievski, Singh & Vahdat (2013) emphasized that effectiveness of multimedia manifest on teachers ease of presentation of different phenomena and processes vividly, simulation of complex content, and presentation of different levels of abstraction [24].

Table 11. Quadratic Formula (Post-test)

Descriptive Value	Numerical Rating	Frequency	Percent
Outstanding	90-100	0	0.00
Very Satisfactory	85-89	146	52.71
Satisfactory	80-84	33	11.91
Fairly Satisfactory	75-79	75	27.08
Did not meet expectation	60-74	23	8.30
Total		**277**	**100.00**
Mean		**82.04**	
		Satisfactory	

Out of 277 student-respondents, there were 146 or 52.71% had very satisfactory achievement ranging from 85-89; 33 or 11.91% obtained an achievement ranging from 80-84; 75 or 27.08% obtained an achievement ranging from 75-79; and 23 or 8.30% of the students obtained an achievement ranging from 60-74 described as Did not meet expectation. The mean of the post-test achievement in quadratic equations in terms of quadratic formula was 82.04, interpreted as Satisfactory. This result indicates that the students' achievement in quadratic equations employing asynchronous online platform method, the achievement of the Grade 9 students was satisfactory in the pre-test and with the use of DepEd TV as asynchronous modality of learning in Mathematics, the performance of the students was also satisfactory in the post-test on the aspect of quadratic equation in terms of quadratic formula.

Based on the student-respondents' appraisal, the use of DepEd TV in education was an effective way to engage and support their understanding of Quadratic Formula as competency under quadratic equations. Deped TV has a great impact on their studies in learning mathematics competencies.

According to the study of Didis & Erbas (2015) stated that students are prone to making arithmetic errors when using the formula, including substitution errors, errors when working with negative numbers as well as issues around the interpretation of √ and ± The quadratic formula does work as a solution method for all quadratic equations unlike factorization (as predominantly only rational roots, or even only integer roots are involved with factorization as a solution method), which has resulted in some teachers choosing only to teach the quadratic formula as a method [25]. Mashudi, Komariah, Irvan (2021) concluded that learning takes place effectively when the teacher sets out to provide learning situation in which a child will learn because of his natural reactions of the provided materials. The attention of the learner is caught and his interest is also won and he is ready to learn [26].

Table 12. Discriminant (Post-test)

Descriptive Value	Numerical Rating	Frequency	Percent
Outstanding	90-100	0	0.00
Very Satisfactory	85-89	185	66.79
Satisfactory	80-84	29	10.47
Fairly Satisfactory	75-79	39	14.08
Did not meet expectation	60-74	24	8.66
Total		**277**	**100.00**
Mean		**83.34**	
		Satisfactory	

Out of 277 student-respondents, there were 185 or 66.79% had very satisfactory achievement ranging from 85-89; 29 or 10.47% obtained an achievement ranging from 80-84; 39 or 14.08% obtained an achievement ranging from 75-79; and 24 or 8.66% of the students obtained an achievement ranging from 60-74 described as Did not meet expectation. The computed mean of the post-test achievement in quadratic equations in terms of discriminant was 83.34 interpreted as Satisfactory. This result implies that the students' achievement in quadratic equations employing asynchronous online platform method, the achievement of the Grade 9 students has improved from did not meet expectation during pre-test and satisfactory in post-test on the aspect of quadratic equation in terms of discriminant.

Based on the student-respondents' appraisal, the use of DepEd TV in education was an effective way to engage and support their understanding in terms of Discriminant as competency under quadratic equations. Deped TV has a great impact on their studies in learning mathematics competencies.

The study of Hwang, Lai & Wang (2015) stated that concept of education and learning has recently changed from old aged instructor-centered approach to learner-centered education modes [27]. With this change, teachers can act as knowledge givers and learning promoters who motivate learners to build knowledge. Information and communication technologies (ICTs) have become an indispensable part of the education system. The system allows incorporating digital technology in a variety of teaching and learning process in higher education [28].

Table 13. Rational Algebraic Equations (Post-test)

Descriptive Value	Numerical Rating	Frequency	Percent
Outstanding	90-100	0	0.00
Very Satisfactory	85-89	157	56.68
Satisfactory	80-84	34	12.27
Fairly Satisfactory	75-79	57	20.58
Did not meet expectation	60-74	29	10.47
Total		**277**	**100.00**
Mean		**82.23**	
		Satisfactory	

Out of 277 student-respondents, there were 157 or 56.68% had very satisfactory achievement ranging from 85-89; 34 or 12.27% obtained an achievement ranging from 80-84; 57 or 20.58% obtained an achievement ranging from 75-79; and 29 or 10.47% of the students obtained an achievement ranging from 60-74 described as Did not meet expectation. The mean of the post-test achievement in quadratic equations in terms of rational algebraic equations was 82.23 interpreted as Satisfactory. This result implies that the students' achievement in quadratic equations employing asynchronous online platform method, the achievement of the Grade 9 students has improved from did not meet expectation during pre-test and satisfactory in post-test. The use of asynchronous online platform method may have contributed to this enhanced learning in quadratic equations in terms of rational algebraic equations.

Based on the student-respondents' appraisal, the use of DepEd TV in education was an effective way to engage and support their understanding of Rational Algebraic Expressions as competency under quadratic equations. Deped TV has a great impact on their studies in learning mathematics competencies.

To use video as a learning tool, Brame (2016) focused on the following principles to be considered by an instructor: keeping videos short and targeting learning goals, conveying right parts of an illustration Focus on important concepts and idea, utilize an enthusiastic and conversational style to increase engagement, and embed videos in a context of active learning by interactive elements, using guiding questions, or associated homework assignments [29].

Table 14. Problem Solving (Post-test)

Descriptive Value	Numerical Rating	Frequency	Percent
Outstanding	90-100	100	36.10
Very Satisfactory	85-89	53	19.13
Satisfactory	80-84	54	19.49
Fairly Satisfactory	75-79	48	17.33
Did not meet expectation	60-74	22	7.94
Total		**277**	**100.00**
Mean		**85.59**	
		Very Satisfactory	

Out of 277 student-respondents, there were 100 or 36.10% had an outstanding achievement ranging from 90-100; 53 or 19.13% obtained an achievement ranging from 85-89; 54 or 19.49% obtained an achievement ranging from 80-84; 48 or 17.33% obtained an achievement ranging from 75-79; and 22 or 7.94% of the students obtained an achievement ranging from 60-74 described as Did not meet expectation. The computed mean score of Grade 9 students in the post-test in quadratic equations in terms of rational algebraic equations was 85.59 interpreted as Very Satisfactory. This result implies that the students' achievement in quadratic equations employing asynchronous online platform method, the achievement of the Grade 9 students has improved from did not meet expectation during pre-test and very satisfactory in post-test on the aspect of quadratic equation in terms of problem solving. The utilization of asynchronous online platform method may have caused the improvement in the achievement of Grade 9 students in quadratic equations in terms of problem solving.

Based on the student-respondents' appraisal, the use of DepEd TV in education was an effective way to engage and support their understanding in terms of Problem Solving as competency under quadratic equations. Deped TV has a great impact on their studies in learning mathematics competencies.

In the study conducted by Ali (2019) on impacts of watching videos on academic performance, recommended that make educational videos more useful to the learners. Animated videos, videos using a whiteboard, live videos, videos combining voice and pictures, and khan academy like videos should be taken into account for creating videos as these types of videos were loved most. Short-length videos should be created because long videos can cause boredom and distraction [30].

Significant Difference on the Achievement of Students between Pre-test and Post-test

Table 15. Test of Difference (Pre-test and Post-test)

	t	df	Sig. (2-tailed)	Decision/ Interpretation
Pre-test and Post-test	-40.09	276	0.00	Ho is Rejected (Significant)

The computed significant value of (0.000) was lower than 0.01 alpha levels of significance, therefore the null hypothesis is rejected.

There was a significant difference on the students' achievement between pre – test and post – test on quadratic equations using asynchronous online platform method. The achievements in the students' pre-test in quadratic equations differ from those in their post-test, which was given after the usage of the reciprocal teaching approach asynchronous online platform method.

The study by Lapada & Lapada (2017) indicated that higher positive LGS means an increase in academic performance from the conducted tests. This situation indicated that the general performance of the experimental group who underwent audio-visual aided instruction was higher than the control group [31]. The result showed conformity with the study of Baer & Vargas (2021) revealed using an independent sample t-test a significant improvement in the posttest score of the experimental group t (50.224) = -3.107, $p < .001$. These findings suggest that watching video lessons from YouTube is effective and can be a possible approach to improving the mathematics achievement of SHS learners [32].

Assessment on the Effects of Asynchronous Modality of Learning Using DepEd TV

The respondents strongly agreed that they feel safer and more comfortable while studying at home with the high mean value of 3.27 (ranked 1st) while agreed that they are more engaged in my studies and lead to higher level of involvement in asynchronous modality of learning with mean of 3.19 (ranked 10th).

Table 16. Effects of Asynchronous Modality of Learning Using DepEd TV

Indicators		AWM	Descriptive Rating	Rank
1	DepEd TV episodes are easy to find with concise and consistent instructions.	3.25	Strongly Agree	4
2	DepEd TV episodes is relevant to the learning competency.	3.27	Strongly Agree	2
3	Watching DepEd TV episodes improves my ability to work independently.	3.25	Strongly Agree	3
4	DepEd TV promotes deep learning and critical thinking.	3.23	Agree	5
5	I feel safer and more comfortable while studying at home.	3.27	Strongly Agree	1
6	I feel motivated in doing my task everyday.	3.10	Agree	9
7	I can revisit lessons as needed to improve comprehension and retention especially in solving worded problems.	3.22	Agree	6
8	Asynchronous learning approach helps introverted students eliminate social anxiety in learning mathematics subjects.	3.11	Agree	8
9	I am more engaged in my studies and lead to a higher level of involvement in asynchronous learning modality.	3.07	Agree	10
10	Students' cognitive development has a profound impact on their ability to succeed in different learning environments.	3.16	Agree	7
Overall Weighted Mean		**3.19**	**Agree**	

The computed overall weighted mean on the assessment of the respondents on the effects of asynchronous modality of learning using DepEd TV was 3.19 with descriptive rating of "Agree". This implied that the junior high school respondents appreciate the enjoyment of learning mathematics using asynchronous modality of learning using DepEd TV.

Based on the appraisal of the student-respondents, DepEd TV is a great initiative of the Department of Education on delivering education easily accessible to them who do not have proper/stable internet access. With the help of DepEd TV, students were able to understand lessons with

a great comprehension of a certain topic in different grade levels. They can watch for free, making accessible to many students unable to attend online classes. Watching Deped TV caters to students 'various learning styles by providing a one-of -a kind combination of sight, sound, motion, and emotion, which can help students better understanding on their lessons. It also helps them to learn complex concepts and improve listening skills it cannot deny the vital role of Deped TV in the country in delivering quality education to students.

If content played a central focus in the past, engagement plays an important role in stimulating online learning today. The shift from a classroom environment to a home learning environment raises another concern for students. Students that have no access to a personal physical online learning environment could be disrupted by noise and other distractions. The pedagogical style also changed. In particular, there are parts of the content of the syllabus that students have to learn on their own (i.e., asynchronous session)—tasks that may not be a practice in a face-to-face setup. The ability of the students to learn and study course material during asynchronous sessions poses difficulties to online learners. These barriers are found to hinder the effective implementation of online learning. However, it is unclear whether these variables have a significant relationship with the students' mathematics online learning self-concept (i.e., perceived abilities of the students to learn online mathematics online courses) [33].

According to Xie, Liu, Bhairma, & Shim (2018) stated that students are more satisfied with asynchronous communication tools, both the quality of learner-content interaction as well as the learner-teacher interaction have a strong effect on satisfaction with learning and perceived learning, especially in asynchronous format [34].

Rapanta, Botturi, Goodyear, Guardia, & Koole (2020) explained that aspects of student activation and interaction are considered in a well-established classification of student-centered and teacher-centered teaching and learning methods that are usually linked to different degrees of active or correspondently passive learning [35].

Hsu, Wang, & Levesque-Bristol (2019) showed that satisfying the basic needs enhances self-regulated motivation, which is associated with higher perceived knowledge transfer and increased achievement of course objectives [36].

Nieuwoudt (2020) expounds that active participation in both synchronous and asynchronous online learning opportunities has resulted in higher engagement and better academic outcomes than attending face-to-face classes only [37].

Fabriz, Mendzheritskaya, & Stehle (2021) concluded that teachers need to put extra effort into providing sufficient opportunities for students to interact not only with the learning content but also with the teacher and their fellow students. Online teaching and learning settings hold potential not only for self-pacing studying, but also for flipped learning arrangements, adaptivity for individual needs, and cooperative tasks [380.

Proposed Intervention Plan

The Mathematics intervention program was developed in response to the pre-test and post-test results conducted in selected Grade 9 students of Zambales National High School. The program was set out to determine effects of asynchronous modality of learning on students' achievement in learning mathematics**.**

Teacher Made Video Lessons Program can be a great way to support all students. It provides learning opportunities for students to learn while they are in their respective areas at home. The video can be viewed by students asynchronously. Making videos for your students doesn't only help them understand written directions but also helps them understand any part of your lessons, including the content.

Utilization of Teacher Made Video Lessons Program in learning Mathematics serves as an intervention material to capture and sustain learners' interest while attaining the targeted competencies in the absence of face-to-face learning due to the Covid-19 pandemic.

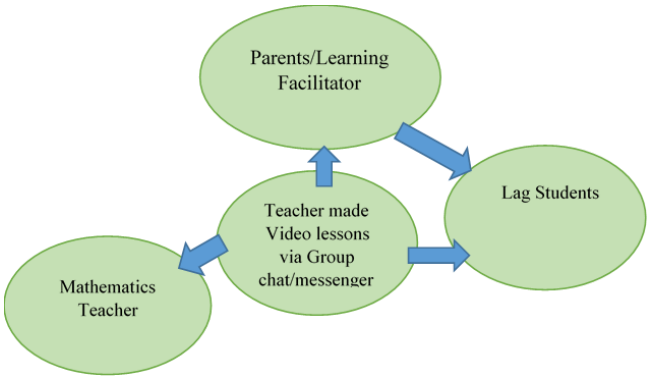

Figure 2. Model of the Teacher-made video lessons Program in Mathematics

Teacher Made Video Lessons Program in Mathematics will be a joint effort of the teachers and the parents/learning facilitators of the learners to deepen students learning in Mathematics. The video can be viewed by students asynchronously via group chat or messenger. It is beneficial for students to access and rewatch videos freely. Teachers can re-use and re-edit videos also.

Videos help students to build relationships and parents may appreciate being able to see how their child is learning.

Utilization of locally made pre-recorded Video Lessons of Zambales National High School Program expect learning outcomes.

The identified Most Essential Learning Competencies (MELCs) in the Mathematics K to 12 Curriculum shall be use in the program. Mathematics teachers are encouraged to contextualize the most essential learning competencies to accommodate the varying context of students and learning environment.

6. Conclusion and Future Scope

The students' achievement during pre-test on quadratic equations in terms of extracting roots was Did not the expectation in terms of completing the square; discriminant; rational algebraic equations and problem solving respectively. While in terms of and quadratic formula and factoring respectively, the students' achievement was Satisfactory during pre – test. Moreover, in terms of extracting roots obtained an achievement of fairly satisfactory. The post-test achievement on quadratic equations in terms of extracting roots; completing the square; and problem solving has a descriptive rating of Very Satisfactory respectively. On the other hand, parameter factoring; discriminant; rational algebraic equations and quadratic formula; and all obtained a descriptive rating of Satisfactory respectively. There was a significant difference on the students' achievement between pre – test and post – test on quadratic equations using asynchronous online platform method. The respondents agreed on the effects of asynchronous modality of learning using DepEd TV. The mathematics intervention program developed based on the appraisal of the respondents was DepEd TV as a tool of asynchronous modality of learners in learning Mathematics among Grade 9 students.

Based on the study's gathered data, students should be free to choose a learning modality where they can focus and set themselves for higher academic success. Mathematics teachers may use the asynchronous modality of learning to improve students' achievement in Mathematics. They may be innovative, passionate, and creative in creating locally produced video lessons to improve the students' achievement in Mathematics. The public secondary school in the Division of Zambales may formulate policies that would encourage teachers to use asynchronous modality of learning for their classes to maximize teachers' potential in making more effective strategies. The school may include in the in – service training (INSET) and workshops the video editing and broadcasting for the professional development and implementation of locally produced video lessons as intervention material in the classroom or at home. DepEd officials may encourage teachers to utilize locally produced video lessons as valid intervention material for teaching Mathematics. Similar studies be made to widen the scope and validate results obtained in this study.

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