Research Article

Electronic Math Problems Analyses and Mastery of Operations, Rules, and Expressions (E-Math Pa More) on the Performance of Grade 9 Students

Jenilyn E. Samaco, Aileen Cabanes, Joemar T. Minoza*

Graduate School of Education, University of the Visayas, Cebu Philippines

ABSTRACT

This study sought to assess the effectiveness of Electronic Math Problems Analyses and Mastery of Operations, Rules, and Expressions (e-MATH PA MORE) as digital learning material in the performance of Grade 9 students of Libagon National High School in Math for the School Year 2022-2023. In order to collect data from the students, this study used a two-group quasi-experimental design including pretest and posttest. The study involved the participation of seventy (70) Grade 9 pupils. One of the two sections, each with 35 pupils, acted as the control group, while the other was the experimental group. To determine the study's findings, the data were statistically treated using inferential statistics, specifically T-test (paired and independent), mean and standard deviation, frequency, and percentage. Based on the study's findings, it is possible to infer that both e-Math PA MORE and the traditional style of teaching are effective in teaching Mathematics. However, a greater improvement in Mathematics performance was noticed in the class when e-Math PA MORE was used, indicating that it is more successful than the old method. Hence, e-Math PA MORE offers learning experiences to aid in the formation of knowledge, particularly in mathematics. Furthermore, teachers should be properly equipped with the information and abilities necessary to create e-Math PA MORE. It is recommended that further studies should be conducted to continually improve the utilization of e-Math PA MORE, accentuating on teachers' preparedness and attitude.

Keywords: *Academic performance, E-learning material, E-Math PA MORE, Mathematics, Math intervention, Quasi-experimental design*

Introduction

Students still believe that mathematics is one of the most difficult subjects in the classroom (Sharma, Fonolahi, Bali, & Narayan, 2018). Most people believe that mathematics is inherently difficult. The majority of students fear this subject because of this perception (Sa'ad, Adamu, & M. Sadiq, 2014). Furthermore, students of mathematics in the twenty-first century bring to the classroom a serious lack of

proficiency as well as dependability in manipulating numbers and algebraic simplification, problem-solving, and a negative attitude (Yeh, Cheng, Chen, Liao, & Chan, 2019).

Asian students are urged to learn Mathematics taking into consideration on its importance just like the other disciplines (Leatham & Peterson, 2010). With the said assumption, students' mathematical accomplishment is guided by far more active practices in most Asian nations (Wei & Dzeng, 2014). Etcuban and Pantinople (2018) stated that this demonstration resulted in an intriguing change in how learning was carried out. Mathematics as mandatory subject in Basic Education Curiculum better known as K-12 is included among the subjects taught to elementary, junior and senior high school to understand and value concepts and principles that can be used along with appropriate technology in their daily lives to solve problems, think critically, communicate, reason out, represent ideas, and make decisions. It plays a significant role and, as a result, practically every area needs it as a subject (Blömeke and Delaney, 2014). Nevertheless, proficiency issues in Mathematics continually prevails in the southeast Asian nations especially in the Philippines. Despite rigorous and careful processes in the making instructional and learning materials which adhere to certain pedagogical standards to provide the learners the best learning experience they could have and acquire necessary and practical skills in Mathematics, low proficiency continually confronts the education department in the Philippines and has even worsen. Care et al. (2015), highlighted that TIMSS findings strengthened the 2013 published report on the significantly decreasing performance of Filipino students on mathematics and science both national and international level which establishes a huge margin from our neighboring countries in the southeast Asia who are well performing like Singapore, South Korea, Hongkong, Chinese Taipei and Japan.

The performance of Filipino students in lessons requiring higher order thinking skills is significantly lower than their performance in sessions requiring knowledge acquisition (Dinglasan & Patena, 2013; Ganal & Guiab, 2014). According to Americans (2009) and Presmeg (2006), even college students have difficulty acquiring and mastering mathematics. In terms of reading comprehension, the Philippines is in bottom place out of 79 nations, while in terms of math and science, it scores in the low 70s (Paris, 2019).

The majority of the country's curriculum now consider math proficiency as essential for both academic success and practical application in daily life. It is regularly discussed since it is viewed as a significant issue for the country's growth and development (Tobias & Diego, 2022).

In the advent of technology, every facet of people's lives is dependent and operated on and by the power of digitalization which urge teachers to utilize them in education settings. Technology is a helpful tool in enhancing the ways teaching and learning is done, which brings significant improvement on education that benefit both teachers and learners. Edtech is one of these technologies that makes education flexible and discerning. In addition, greater opportunities of advanced learning become possible with all the technology driven instructional tools and materials, free internet resources, personalized learning materials, more fascinating information, enhanced visual comprehension.

In this digital world, people cannot refute the significance of technology in assessment processes in education which is upheld by some organizations like the International Society for Technology in Education (ISTE). With the use of technology-driven education system, students experience a kind of learning that is creative and solution-driven. Technology plays a critical role in education since it permits teachers to deliver all learning resources, which helps students comprehend the material and solve problems more quickly. Modern classrooms and "Smart" classes use educational technology to improve each student's performance. The significant contribution of technology to education has improved the basics of teaching and learning process; heightened classrooms interactions which supports students in the acquisition of skills and competencies. Furthermore, E-learning technology allows learning materials to be portable or handy (Edmonger, 2021).

In Libagon National High School, it has been very challenging for Mathematics teachers and students as to how to improve their performance in Math in general. Challenges in distance learning and school year ends considerably lead to projected academic learning gaps and losses (Cho et al., 2021). Their poor academic performance has been greatly influenced by the abrupt change in learning modality that occurred for two years as a result of the pandemic.

Electronic Math Problem Analyses and Mastery of Operations, Rules and Expressions (e-MATH PA MORE) is a learning material in Math which involves problem analysis, mastery of operations, rules and mathematical expressions implemented with the utilization of digital technologies digital gadgets like cellular phones, laptops, and tablets made available to the students through a Kotobee app and reader.

Hence this study is primarily to find out if there is an improvement in grade 9 students' performance in Mathematics in general with the use of Electronic Math Problems Analyses and Mastery of Operations, Rules, and Expressions (e-MATH PA MORE). This study will help teachers discover a solution to concerns with low performance in mathematics while also integrating the needs of the 21st century, given how the pandemic affects students' performance in mathematics and how students are attracted toward technology. The study's findings will also be used as a foundation for the development of instructional materials that will improve and enhance students' mathematics performance. They will also serve as an "eye-opener" for the department as it makes investments in the professional development of its teachers and develops strategies to raise students' standards generally.

Literature Review

This study is grounded on the Cognitive Load Theory (CLT), which was established by John Sweller in 1988 and contends that learning becomes possible and enhanced when instructional models do not over capacitate students working mind with abundant information.

According to cognitive load theory, a big, long-term memory is used to store newly learned knowledge for later use, while a small working memory is employed to comprehend novel information. Long-term memory storage is what instruction is all about. Everything that has been taught, from simple, rote facts to intricate, fully comprehended concepts and procedures, is included in that information. The term "learning" refers to a development of long-term memory. Nothing has been learned if long-term memory has not been altered.

The theory has been utilized to encourage a variety of teaching strategies. These strategies are designed to lessen the workloads on students' memory through easier information storage of lasting memory. One strategy focuses on the impermanent data impact, which is directly tied to the way information is transmitted via instructional technology.

When using technology to impart knowledge to students, the presentation's modality and format are regularly altered. For instance, spoken information may take the place of written information, and animated images could take the place of the static graphics seen in hard copies. Although these modifications are often well known to instructional designers, there is another simultaneous but less evident alteration that takes place. A generally permanent form of information, like written text or visual images, is replaced by a very temporary form, like speech or animation. This modification is frequently overlooked and viewed as trivial. According to the the theory of cognitive load, it might be crucial. Transient, technological information has significant educational repercussions, many of them unfavorable, because human working memory is limited. The transitory information effect's theory and research will be examined in connection to e-learning.

Students' Academic Performance and Challenges in Mathematics

Performance in mathematics has been identified as critical in most programs across the country, not exclusively for successful academics but also for practical use in daily life (Tobias and Diego, 2022). According to Segumpan and Tan (2022), the outcome of intertwined procedures conducted in the class is called Mathematics performance, which is also

influenced by students' attitude towards the subject and the teachers' pedagogy. Oftentimes, students' performance in mathematics is ascribed to teachers' pedagogy more that students' motivation and attitude towards learning, which is inappropriate since the two should be intertwined.

As stated by Generalao, as cited by Andamon and Tan (2018), students' performance in Mathematics is immensely influenced on the teachers' pedagogical creativity and resourcefulness making their roles critical in the teaching and learning of mathematics. Despite being highly intellectual and challenging, mathematics will still be easier to learn if instructions are engaging and accommodating. According to the claims, mathematics performance is influenced by how students viewed instruction in the classroom. Minao (2013) connects mathematics to every detail in the universe and argues that it is the foundation of all science and technology courses. The emphasis on Mathematics as a necessary topic to learn stems from the basic reason that it is everywhere and is used the daily lives of every individual. Furthermore, Mathematics help people answer most of the questions in this world. Despite its importance and its practicality, Mathematics is still one of those subjects that learners struggle as teachers find it difficult to teach it outside the four corners of the classroom. Teachers find it challenging in bringing their students in the real-life situations of Mathematics leading to low proficiency among learners.

Pal (2009) cited in Vellaichamy (2019) even added that the numerous difficulties that students faced in learning were rooted in a lack of understanding of lower-level concepts. One of the factors that triggers these reasons is the lack of clarity of the given instructions, which leads to misunderstandings that affect the learning of mathematics. According to Honor, as cited by Pagtulon-an and Tan (2018), there are various factors and reasons that hinder and challenge students desire to learn and perform well in Mathematics lessons and set competencies. These reasons include the environment of the classroom, the personalities of the teachers towards the students, and the teaching styles and methods they incorporate. One of the grounds for these hindrances that cease the

learning of the students is the lack of accountability of teachers to innovate their teaching styles, which are only occupied with what they are used to doing. This is also a manifestation that the traditional approach to teaching cannot cater to the needs of all the students and is not productive enough to encourage them to learn.

Ulep (2006) explained the teaching of Mathematics in the Philippine setting. One thing that a Filipino Mathematics teacher must always take into consideration is to develop and familiarize open-ended activities involving practical work in every classroom instruction. She added that Filipino teachers must prepare to involve and manage cooperative learning groups to maximize the benefits of each instruction. Sadly, in general, still, to a great extent, it was the teacher who explains and asks questions in a whole classroom setting. Students cannot sustain the discussion and make it more productive, leaving the teacher as the one who begins and ends the topic. 'The most common strategies in teaching mathematics are exposition, practice and consolidation, and discussion' (High School Mathematics Education Group 1996; Bernardo, SalazarClemena, and Prudente 2000) as cited by Ulep (2006).

Furthermore, in connection to students' mathematics performance, Dalan (2004) emphasized that achievement of the students plays an important role as a basis for developing educational system specifically in the teaching and learning process. Academic performance now is a criterion in identifying whether the instruction the teacher offers is considered of quality or just mediocre. Similarly, Tobias and Diego (2022), found that mathematics performance is accounted for by the teacher factors. The teacher's experience and knowledge of the subject are important indicators to involve students in meaningful and effective mathematical practices in learning. As a result, students can develop a deep understanding of mathematics. The ability to use different teaching strategies in dealing with mathematics and finding the best methods to present the content effectively facilitate successful learning. Hence, it is essential to identify the best methods, techniques, and strategies employed by the teachers, which will help future students to

have better entry-level mathematics performance.

In the Philippines, mathematics is a general education subject in primary and higher education where learners are expected to gain understanding and appreciation of its principles as an applied-using appropriate technology in problem-solving, critical thinking, communicating, reasoning, making connections, representations, and decisions in real life (K to 12 Basic Education Curriculum). However, problems related to mathematics achievement are still evident not only in the Philippine setting but also right in other countries (Blömeke and Delaney, 2014). The participation of the Philippines in TIMSS confirmed this deplorable condition-based from the report posted last 2013 that the performance of Filipino students in national and international surveys on mathematics and science competencies lag its neighboring countries like Singapore, South Korea, Hongkong, Chinese Taipei and Japan (Care et al., 2015).

Students' performance in mathematics, as indicated by the grades they achieved, is affected by various factors. Among the various factors, this study will primarily deal with students' affective characteristics, which focus on study habits and study attitudes, which are then further referred to as study orientations as reiterated by Biswas (2015). Guinocor et, al., (2020) mentioned that In Asia, mathematics is viewed as one of the most critical subjects wherein students are encouraged to study the discipline (Leatham & Peterson, 2010) that it is in this view that in most Asian countries, guiding practices on children's mathematics achievements are quite more vigorous (Wei & Dzeng, 2014). As indicated by Etcuban and Pantinople (2018), that showing acquired an attractive change in the conduct of learning. According to recent research that the attitude of the learners towards mathematics may also affect the performance of the said subject.

Educational services are often not tangible and are difficult to measure because they result in the form of transformation of knowledge, life skills and behavior modification of learners, Tsinidou, Georgianni, &Fitsilis, (2010). Students' ability to manage their "thoughts, behaviors, and emotions in order to successfully navigate their learning experiences" is known as self-regulated learning (Zumbrum, Tadlock, & Roberts, 2011).

According to other research studies that in learning mathematics, there are many reasons and factors that affects the performance of the students and one of the factors is the strategy being used by the teacher affecting children in learning effectively the context of mathematics. Despite of the innovative teaching strategies evolved today, performance of the students in Mathematics remains low and alarming. This is shown in the result of the Third International Mathematics and Science Study (TIMSS) where the Philippines ranked as 39th out of 41 participating international countries according to Mullis as cited by Tan and Cordova (2018). It implies that educational system in our country has a problem in different aspects especially on mathematics education.

Mathematics teachers may use the necessary and available technology to enhance learning. Teachers may also consider the concept of having prepared instructions done outside the class schedule. Teachers are encouraged to refrain from using home-based activities like assignments as a final summary of the previous lesson, but rather, to use them as an introduction and pre-discussion of the next lesson. Mathematics teachers are also challenged to learn making interactive instructional videos and to create online portals which can be used as e-classrooms (Segumpan et al., 2022). Eyyan and Yaratan (2014) found that the use of educational technology had a positive effect on their performance, and the impact of the use of technology can be seen in the students' progress results.

The enabling factors that have a significant relationship with the mathematics performance of students are observed to originate from a combination of different reasons. It indicates that teaching strategies and methods that best suit specific objectives and exit outcomes emerged as the most influential factor in the performance of students in mathematics. How teachers view mathematics, such as its usefulness in life and approaches to learning math, impacts the student's performance. Teachers' commitment to teaching by lending extra help to students beyond their working hours, knowledge of the content, openness to

suggestions, and being worthy of praise make students feel at ease in handling the subject. This means that teachers' active listening and encouragement and the provision of fun, supported, and challenging environments where students could learn and appreciate greatly affect their performance in mathematics (Tobias and Diego, 2022).

The integration of e-learning and technology in general is proved to be a significant contributor to student performance in general and in Math in particular based on the many readings and extensive data mining and information of the researcher. It is undeniable that mathematics plays a crucial role in everyone's life, particularly that of our students who are eager to learn more about the world that awaits them in the future. As a result, math teachers work tirelessly to ensure that their students have the best possible math learning experiences, which will ultimately inspire them to love math and perform at their highest level academically

Furthermore, teachers can take advantage from the current technological interest of our students to make this possible. They will get a new level of experience if technology is incorporated into the classroom or if eLearning is used, both of which practically all students can access. As a result, students will have control over their learning because it will be accessible from anywhere and at any time. Students will have opportunity to explore on their own, which will help them develop essential skills, and teachers can act as learning facilitators. Nevertheless, teachers also need to make sure to properly integrate technology without compromising the different competencies or aspects in terms of subject matter that the students need to learn.

E-learning Integration in Education

According to Berrocoso et al. (2020), e-learning is a cutting-edge web-based educational system designed to provide students a more conducive learning environment that upholds and fosters learning that is student-centered. According to North Carolina's eLearning education project, e-learning is a concept that goes beyond the outdated classroom set up through the use digital technologies in utilizing educational materials and lessons. The basic tenet is to move from facilitative learning toward self-directed learning, where academics use various strategies by acknowledging students' past experiences and learning styles to encourage the students to become independent students (Islam et al., 2015).

The learning process uses online-based communication, offline digital technologies for electronic media (i.e., pdf files, videos, e-Learning modules), or even the use of other e-Learning platforms like moodle, google classroom, digital class applications, and the like. Additionally, e-Learning is the utilization of electronic and digital technologies to view online the curriculum of a degree that is accomplished (Salamat et al., 2018).

The main belief of an e-learning in education is a kind of learning with the intervention of technology that could be of potential benefit to learners (Berrocoso, 2020). Technology's quick development is fundamentally altering social standards. Recent studies reveal that social media networks are crucial to the school system because they draw students in and let them connect with the rest of the world. According to Anshari et al. (2016), e-students desire to use new technologies to learn and interact with individuals who are involved in their education.

The kind of training in education digitally delivered is called e-learning. This kind of learning complements the traditional way through the use of technological devices that are connected online making learning becomes simpler and more accessible. According to Lawless (n.d.), e-Learning is definitely significant to trainings and learning processes conducted online using digital technologies like computers.

Carreon (2018) found that there is a need to incorporate digital learning tools with contextualized pedagogy necessary for the progress of the desired skills of this time. The study found that using Facebook as a common platform of social media is very effective in motivating and increasing the students' confidence. Based on the assumption that the use of Facebook has been widely accepted and practiced, thereby becoming part of the culture, especially of the so-called Generation Z.

In the study of Salamat et al. (2018), e-Learning was found to provide several advantages for the students such flexibility and independent learning. Moreover, it encourages active engagement and involvement from students during classroom discussions. Even though there are many situations where using technology presents challenges, doing so allows students to continue their study and gain further knowledge. It is important to keep in mind, though, that merely adopting e-Learning technologies may not result in the platform's integration into the teaching and learning processes unless purposeful actions are taken to do so (Dagana & Chigona, 2015). To successfully integrate e-Learning technology into education, school management, instructors, students, and other community stakeholders must cooperate.

With the advent of the continuously evolving use of technology, there is always an urgent call for the educational system to adapt to these advancements through effective and efficient teaching and learning. The current pandemic situation strengthened the call to maximize the use of blended learning. The World Bank (2020) specifically calls for different strategies to at least minimize the influence of the pandemic in learners' education. Unfortunately, developed countries are more equipped and prepared to move to online learning strategies. In contrast, the less developed countries are a combination of mixed and vast inequalities in terms of technology and digital gadgets, hence, providing options for the utilization of multi-modalities of learning, which covers the use of the cyberspace, radio, television, or modules (Saavedra, 2020).

The limitations on the complete integration of e-Learning in the teaching and learning process in the study of Spiteri and Rundgren (2020), wherein the major determinant factors are the teachers' use of digital technologies such as teachers' knowledge, attitudes, and skills, and culture in the school. The study claimed that the increasing use of the teachers in digital technology did not result in progress concerning students' academic achievement due to the lack and inappropriate training provided to the teachers. The teachers have used digital platforms, but due to a lack of proper training, these learning materials do not necessarily result in a higher rate of students' academic performance.

Teachers' job to practically and effectively impart and develop Math knowledge and competence among students of developing countries has been a perennial concern. This concern could be addressed for a more enhanced and more enjoyable mathematics learning experience if students' behavior towards learning Mathematic is well analyzed and supplemented with the appropriate use of e-learning (Ahn and Edwin, 2018).

The U.S. National Council of Teachers of Mathematics, contends that "Technology is an essential tool for learning mathematics in the 21st century, and all schools must ensure that all their students have access to technology" (NCTM 2008). The preliminary stage of mathematics learning recognizes the fast-developing significance of mobile-digital technology as current research revealed (Drijvers,2015).

In a study titled "E-Learning in the Teaching of Mathematics: An Educational Experience in Adult High School" of Guerro et al., (2020) It was revealed that independent learning is manifested by the use of e-learning where teachers really play the role of a facilitator and the students becomes more responsible of his learning. This kind of learning fosters independence, engagement, and motivation, which could result to a successful transfer of learning as this allows students to be actively involved and independent towards learning which are all indicators of effective teaching-learning process.

Creation of e-Math PA MORE

Mathematical e-learning becomes more effective if users have necessary software supplemented by tested and proven pedagogical principles and practices to accommodate and equate the needs of the students and the objectives of the teachers. Encumbrances towards effective implementation of e-learning in mathematics among developing countries have been the been the common dilemma; hence, cost, usability and impact on learning are advised to be focused on by the implementers of the said method (Ahn and Edwin, 2018). Electronic Math Problems Analyses and Mastery of Operations, Rules and Expressions (e-Math PA

MORE) is an e-Learning material in Math that was made possible through a Kotobee application (Kotobee Author and reader) which is a free e-book or epub platform creator. E-Math PA MORE is a compilation of modules and videos for all the topics or objectives for the entire quarter which involves math problems analyses, mastery of operations rules and expressions sourced out by the researcher for the students that serve as an alternative or intervention in enhancing students' performance in Mathematics is likewise taking advantage of the usage of technology of the students nowadays. According to Ahn and Edwin (2018), Mathematics' system of language and symbols makes it unique from the other disciplines taught. Consequently, making its language and symbol as basis in creating an e-learning effective. Moreover, an effective e-learning is a one stop e-learning making it possible to integrate note-taking of students and setting up of organized, active and highly engaging mathematical problems of the teachers in the system.

The contents of the e-Math PA MORE are aligned with the learning competency in Mathematics provided by the Department of Education (DepEd). According to the blog of Kasper Aspiro about E-learning best practices: Effective e-learning content is suited to learners' objectives and needs, as well as your organization's overall structure, resources, and goals, according to the nine cornerstones of effective course production. Hermann Ebbinghaus revealed in 1885 that humans forget 90% of what they are taught within hours of learning it as a result of how the human brain is structured. The key to remembering information is repetition. As a result, the most effective courses are not long, singular occurrences, but rather a succession of little, repeating modules delivered gradually. This entails giving pupils chances to go over the lesson in numerous ways. Consequently, this e-learning resource was created so that students were provided with access to an electronic learning resource that they could use from anywhere and at any time using whatever devices they had.

Thus, students' academic performance can be improved, and challenges towards mathematics can be mitigated through the integration of e-learning materials like e-MATH PA MORE with teachers' ample experience and knowledge of its utilization.

Methodology

This study utilized a quasi – experimental design in two groups using pretest and posttest in gathering the data of the students. Quasi-experimental studies used both pre-intervention and post intervention measurements as well as non-randomly selected control groups. This design aimed to determine the performance of Grade 9 students in Mathematics in the utilization of electronic Math problem analysis and mastery of operations, rules and expressions through the Kotobee application.

There were seventy students (70) grade nine students of Libagon National High School in Libagon District participated in the study. There were 111 grade nine students in the school mentioned and with the use of cluster sampling, the researcher drew two sections out of three which composes a total of 70 students as part of the study. The study's participants were all from the same school, and the researcher herself is a teacher of the said school. These pupils were separated into two groups of 35 students each: the Control group and the Experimental group. These two groups were assigned by a coin toss. One group was the experimental group, which was exposed to e-Math PA MORE via the Kotobee app, and the other was the control group, which was not subjected to the intervention. The students' parents willingly consented to their children participating in the study as long as they were physically and emotionally stable during data collection.

This study utilized a pretest and posttest questionnaire for data collection. The questionnaire was adopted or sourced out from Regional Test Item Bank for grade nine Mathematics which was mandated by the Department of Education. The said questionnaire consisted of 20 item equivalent test in which there were 5 items per mathematic skill such as Math problem analyses, mastery of operations, mastery of rules and mastery of mathematical expressions) and the same questionnaire was answered by the two groups of respondents. The pretest was administered prior to the exposure of the students to e-Math PA MORE using a Kotobee app, while the post test was used to

measure the achievement of the students after the exposure of the treatment. The appropriateness of the structure, adequacy of the questions, and comprehensiveness with the objectives given in the collection of domains in the Table of Specifications were used to validate the content. The questions were taken from the DepEd Regional Test Item Bank for Mathematics 9. The purpose of the questionnaire was to determine the effectiveness of electronic Math problem analyses and mastery of operations, rules and expressions in the mathematics performance of grade nine students in Libagon National High School, Jubas, Libagon Southern Leyte.

Permission was obtained before the study was conducted, and the participants signed consent forms attesting to their voluntary participation after the researchers explained them.

When data were collected, Frequency, Percentage, Mean and Standard Deviation and T test for dependent samples were utilized in analyzing and interpreting the gathered data on the performance of Grade 9 students S.Y 2022 – 2023. The T test for independent samples was used to see if there was a significant difference between the control and experimental groups. It was used to assess the impact of e-Math PA MORE on the math performance of Grade 9 pupils.

Results

This section displays the analysis and interpretation of information accumulated from the subject of the study, which is the 9th grade students at Libagon National High School in Libagon District for the school year 2022-2023.

Table 1. *Pretest Performance of the Control and Experimental Group*

	Group	Mean	Std. Deviation	Mean Percentage Score (MPS)	Interpretation
Math Pretest	**Control Group**				
	analysis	2.03	0.13	40.6	Did not meet expectations
	operations	1.89	0.11	37.8	Did not meet expectations
	rules	2.11	0.11	42.2	Did not meet expectations
	math expressions	1.94	0.12	38.8	Did not meet expectations
	Overall Score	7.97	1.38	39.85	Did not meet expectations
	Experimental Group				
	analysis	2.09	0.16	41.8	Did not meet expectations
	operations	2.11	0.14	42.2	Did not meet expectations
	rules	2.06	0.16	41.2	Did not meet expectations
	math expressions	2	0.14	40	Did not meet expectations
	Overall Score	8.26	2	41.3	Did not meet expectations

Note: 90-100 – outstanding, 85-89 -very satisfactory, 80-84– satisfactory 75-79 – fairly satisfactory, 74 below – did not meet expectations

Table 1 revealed the results of the pretest for the control and experimental groups. The researcher incorporates an independent test to determine the mean scores of pretests between the control and experimental groups, including the mean percentage score (MPS). For the control group pretest, it was found out for the analysis, operations, rules, and expressions that the mean scores are (2.03, 1.89, 2.11, 1.94) with MPS of (40.6, 37.8, 42.2, 38.8). Additionally, it was also found out for the experimental group that the mean scores are (2.09, 2.11, 2.06, 2)

with MPS (41.8, 42.2, 41.2, 40), respectively. Based on the results, it can be perceived that the MPS of the two respective groups did not meet the expectations, which implies that the learners had low performance in the pretest.

The pretest results clearly demonstrated that the control and experimental groups were perceived as failing to satisfy expectations. By implication, both groups demonstrated that the learners performed poorly on the pretest and that the results for both groups are only comparable.

Table 2. Posttest Performance of the Control and Experimental Group

	Group	Mean	Std. Deviation	Mean Percentage Score (MPS)	Interpretation
Math Posttest	Control group				
	analysis	2.51	0.10	50.2	Did not meet expectations
	operations	2.46	0.11	49.2	Did not meet expectations
	rules	2.4	0.10	48	Did not meet expectations
	math expressions	2.49	0.13	49.8	Did not meet expectations
	Experimental group				
	analysis	3.43	0.14	68.6	Did not meet expectations
	operations	3.69	0.15	73.8	Did not meet expectations
	rules	3.51	0.14	70.2	Did not meet expectations
	math expressions	3.46	0.17	69.2	Did not meet expectations

Note: 90-100 – outstanding, 85-89 -very satisfactory, 80-84– satisfactory 75-79 – fairly satisfactory, 74 below – did not meet expectations.

Based on the table presented, it can be perceived that the Experimental Group thoroughly displayed great performance compared to the Control Group. Hence, it suggests that learners demonstrate better mathematical skills when incorporated with the use of e-MATH PA MORE. Moreover, it is evident from the result that having the e-learning material intervention in math and having the teachers serve as facilitators during the lesson improves the potential of the students in learning mathematics. According to Almerino et al. (2020) and Biswas (2015), "Students' competence in mathematics, as reflected by the grades they accomplished, is influenced by multiple components." These include the affective attributes of the students and the quality of focus they manifest in their study.

Moreno-Guerrero et al. (2020) also state that the use of e-learning in the development of mathematics promotes student dedication, which improves efficiency. It also raises the interest of the students, which is a vital factor in wanting the students to focus and learn. With the incorporation of e-learning, it will serve as a great tool to effectively and efficiently help students achieve educational content. The e-learning teaching approach defies traditional assumptions of teaching and learning processes since e-learning makes every aspect of learning accessible at any time and place, giving the learner convenience. This has been attainable due to technological advancements and interconnected networks. Hence, this makes the experimental group perform better than the control group as indicated in the table.

Table 3. Comparison between the Pretest of the Control and Experimental Group

		Mean	Std. Deviation	t-value	p	Decision	Interpretation
Pretest	Control Group	7.97	1.38	0.62	0.27	Fail to reject Null Hypothesis	There is no significant difference.
	Experimental Group	8.26	2	0.62	0.27		

Based on the table presented above, the pretests of both groups are comparable, and there was a similarity in the performance of the learners before the e-MATH PA MORE was incorporated. In accordance with "*Strategies-for-Improving-Student-Retention.pdf*" (2014), assessment and feedback opportunities not only

foster self-reflection on progress but also help students to "think about what they are learning as they are learning." Thus, engaging students in the learning process in the classroom may significantly impact students' achievement and persistence and even help students build critical thinking skills.

Table 4. Results of the dependent t test of the Control and Experimental Group

		Mean	Std. Deviation	t-value	P	Decision	Interpretation
Control Group	Pretest	7.97	1.38	-5.95	<001	Reject Null Hypothesis	There is significant mean gain.
	Posttest	9.86	1.75				
Experimental Group	Pretest	8.26	2	-15.75	<001		
	Posttest	14.09	2.85				

The researcher conducted a t test to effectively evaluate the students' improvement. The grade 9 students were exposed to the traditional approach and e-Math PA MORE, accordingly. There were dependent samples with the mean gain between the pretest and posttest of the control group (t = -5.95, p = 0.001). For the traditional approach, it was found that the pretest mean has a score of 7.97, while the posttest mean has a score of 9.86, which suggests that there were positive results for the control groups based on the performance of the students that served as the subject of the study. Furthermore, for the students that were exposed to e-Math PA MORE, it was found that the pre-test mean score is 8.26, while the post-test mean score is 14.09, respectively. Based on the results, it shows that the dependent samples for both pre-test and post-test have a significant difference (t = -15.75, p =.001), which indicates that there were way better and more remarkable results in the performance of the experimental group that were exposed to the e-Math PA MORE compared to the students that were exposed to the control group.

By implication, although there was a positive result based on the performance of the control group in the exposure of the traditional approach, it is still noteworthy that the performance of the experimental group that were exposed to e-Math PA MORE is more convincing to the control group. Additionally, both the traditional method and e-MATH PA MORE are effective in improving performance in mathematics. However, the students that were significantly exposed to e-Math PA MORE have greater development, which means that the integration of e-Math PA MORE is a more effective approach to helping the students in mathematical aspects. Al-Tordy (2009) highlights that one of the factors that provides learners with a great learning environment and emphasizes an inclusive educational system is e-learning. Al-Todry (2009) also added that e-learning provides advanced delivery of education and helps both the teachers and the learners be exposed to other educational settings and technology-driven education.

Table 5. Results of the dependent t test of the Mean-Gain Difference Control and Experimental Group

		Mean	Mean-gain difference	Std. Deviation	t-value	p	Decision	Interpretation
Control Group	Pretest	7.97	1.89	1.38	-5.95	<001	Reject Null Hypothesis	There is significant mean gain difference.
	Posttest	9.86		1.75				
Experimental Group	Pretest	8.26	5.83	2	-15.75	<001		
	Posttest	14.09		2.85				

The researcher conducted an independent t test to test the hypothesis and analyze the two subject groups. The level of significance was set at p < 0.05. Based on the results, it was found that the performance of the students between the control and experimental groups in enhancing their mathematics performance with e-

Math PA MORE had a significant difference, respectively. The results also imply that there was a worthy development of students that were exposed to e-Math PA MORE.

Haury and Rillero (2015) presume that looking out for the children effectively and efficiently during their learning experience will

help the children to focus on the subject matter and help them improve their learning ability to think critically. Hence, the traditional method and e-Math PA MORE are both effective in teaching mathematics. Nonetheless, the results revealed that the students that were exposed to e-Math PA MORE had a more significant improvement, which greatly suggests that the incorporation of e-Math PA MORE is more effective in learning mathematics compared to the traditional approach. This conforms to Salamat et al. (2018) and Berrocoso et al. (2020) that e-learning encourages active engagement and involvement from students during classroom discussions, leading to a better academic performance. Findings also suggest that e-Math Pa More was well utilized by the teacher leading to the improved performance of the students which supports to the idea that learning Mathematic becomes better if supplemented with the appropriate use of e-learning (Ahn and Edwin, 2018)

Conclusion

Based on the findings of the study, it can be concluded that e-Math PA MORE and the traditional method of teaching are both effective in teaching mathematics. However, it is evident that there is a significant improvement in the performance of the students when incorporated with e-Math PA MORE. This indicates that using e-Math PA MORE provides greater effectiveness when learning mathematics compared to the traditional approach. E-Math PA MORE offers learning experiences that help in the development of knowledge, particularly in mathematics. This overall finding of the effectiveness of e-Math PA MORE conforms to the existing literature revealing e-learning's effectiveness towards learning mathematics. Furthermore, this supports that e-learning upholds and fosters learning that is student-centered, as it provides students a choice to investigate additional resources that would provide them with further information on a specific problem, making learning evidently independent and effective as indicated in the mean gain of their pre and posttest scores. The overall findings likewise suggests that the teacher was able to effectively use e-Math Pa More. However, this

study limits on the effectiveness of the electronic learning material and does not focus on how math teachers are well prepared to utilize such, making teaching and learning more meaningful. Hence, this study recommends that teachers' preparedness and even attitude towards the utilization of e-learning material be studied.

References

Abou El-Seoud, M. S., Taj-Eddin, I. A., Seddiek, N., El-Khouly, M. M., & Nosseir, A. (2014). E-Learning and Students. International Journal of Emerging Technologies in Learning (iJET), 9(4), 20. https://doi.org/10.3991/ijet.v9i4.3465

Al-Todry, Awad Hussein (2009): "Educational Technology: Its Innovations and Applications", Faculty of Education, Assiut University.

Almerino, P., Guinocor, M., Mamites, I., Lumayag, C., Villaganas, M. A., & Capuyan, M. (2020). Mathematics Performance of Students in a Philippine State University. *International Electronic Journal of Mathematics Education*, 15(3). https://doi.org/10.29333/iejme/7859

Americans, W. A. (2009). It doesn't add up African American students' mathematics achievement. Secondary Lenses on Learning Participant Book: Team Leadership for Mathematics in Middle and High Schools, 149. Retrieved from http://bit.ly/2IaUOrL

Ahn, J. Y., & Edwin, A. (2018). An e-Learning Model for Teaching Mathematics on an Open Source Learning Platform. The International Review of Research in Open and Distributed Learning, 19(5). https://doi.org/10.19173/irrodl.v19i5.3733

Andamon, Jocelyn & Tan, Denis. (2018). Conceptual Understanding, Attitude And Performance In Mathematics Of Grade 7 Students. *International Journal of Scientific & Technology Research*. 07(8), 96-105.

Anshari, M., Alas, Y., Hardaker, G., Jaidin, J., Smith, M., & Ahad, A. (2016). Smartphone habit and behavior in Brunei: Personalization, gender, and generation gap. Computers in Human Behavior, 64, 719-727. https://doi.org/10.1016/j.chb.2016.07.063

Biswas, S. K. (2015). Influence of Sex on Students' Study Orientation at Secondary Level.

Advances in Social Sciences Research Journal, 2(10). https://doi.org/10.14738/assrj.210.1355

Blömeke, S., & Delaney, S. (2014). Assessment of Teacher Knowledge Across Countries: A Review of the State of Research. *International Perspectives on Teacher Knowledge, Beliefs and Opportunities to Learn,* 541-585. https://doi.org/10.1007/978-94-007-6437-8_25

Braun V., Clarke V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, 3(2), 77–101.

Care, E., Azim, F., Beswick, B., Harding, S. M., Luo, R., Bustos, T., & Cagasan, L. (2015). Large-scale assessments for use in the Philippines. Retrieved from http://bit.ly/2G0PvYq

Carreon, J. R. (2018). Facebook as integrated blended learning tool in technology and livelihood education exploratory. *International Journal of Educational Technology*, 5(2), 19-25

Cho, Y., Avalos, J., Kawasoe, Y., Johnson, D., & Rodriguez, R. (2021). The Impact of the COVID-19 Pandemic on Low Income Households in the Philippines. https://doi.org/10.1596/35260

Dinglasan, B. L., & Patena, A. (2013). Students performance on departmental examination: Basis for math intervention program. University of Alberta School of Business Research Paper, (2013-1308). Retrieved from http://bit.ly/2uYhfrk

Drijvers, P. (2015). Digital Technology in Mathematics Education: Why It Works (Or Doesn't). Selected Regular Lectures from the 12th International Congress on Mathematical Education, 135-151. https://doi.org/10.1007/978-3-319-17187-6_8

Edmonger. (2021, July 28). *EdMonger.* Retrieved from Edmonger: https://edmonger.com/2021/07/28/roles-of-technology-in-education/

Etcuban, J. O., & Pantinople, L. D. (2018). The Effects of Mobile Application in Teaching High School Mathematics*. International Electronic Journal of Mathematics Education, 13*(3), 249-259. https://doi.org/10.12973/iejme/3906

Eyyam, R., & Yaratan, H. (2014). Impact of use of technology in mathematics lessons on student achievement and attitudes. *Social Behavior and Personality: An international journal, 42*(0), S31-S42.

Ganal, N. N., & Guiab, M. R. (2014). Problems and difficulties encountered by students towards mastering learning competencies in mathematics. *Researchers World, 5(*4), 25. Retrieved from http://bit.ly/2X0dJc8

Hernawati, K., & Jailani,. (2019). Mathematics mobile learning with TPACK framework. Journal of Physics: Conference Series, 1321(2), 022126. https://doi.org/10.1088/1742-6596/1321/2/022126

Haury, D.L. and Rillero, P. "Perspectives of Hands-On Science Teaching". www.ncrel.org/sdrs/areas/issues/content/cntareas/science/.../eric-1.html

Islam, Md. K., Sarker, Md. F. H., & Islam, M. S. (2022). Promoting student-centred blended learning in higher education: A model. *E-Learning and Digital Media, 19*(1), 36-54. https://doi.org/10.1177/20427530211027721

Lawless, C. (n.d.). *Learn Upon Blog*. Retrieved from Learn Upon Website: https://www.learnupon.com/blog/what-is-elearning/

Leatham, K. R., & Peterson, B. E. (2010). Secondary mathematics cooperating teachers' perceptions of the purpose of student teaching. *Journal of Mathematics Teacher Education, 13*(2), 99-119. https://doi.org/10.1007/s10857-009-9125-0

Saavedra, J. (2020). Educational Challenges and Opportunities of the Coronavirus (COVID-19) Pandemic. World Bank Blogs.

Salamat, L., Ahmad, G., Bakht, I., & Saifi, I. L. (2018). Effects of E–Learning on Students' Academiclearning at university Level. *Asian Innovative Journal of Social Sciences and Humanities, 2*(2), 1-12.

Segumpan, Lester Lou & Segumpan, Benguar & Tan, Denis. (2018). MATHEMATICS PERFORMANCE AND ANXIETY OF JUNIOR HIGH SCHOOL STUDENTS IN A FLIPPED CLASSROOM. 10.5281/zenodo.1325918.

Sharma, B. N., Fonolahi, A. V., Bali, A., & Narayan, S. S. (2018). The Online Mathematics Diagnostic Tool for Transformative Learning in the Pacific. Cases on Smart Learning Environments, 63-80. https://doi.org/10.4018/978-1-5225-6136-1.ch005

Montanes, S. M. (2022). DEVELOPMENT AND EVALUATION OF GRADE 9 TLE-COOKERY APPLICATION USING RAPID INSTRUCTIONAL DESIGN (RID) MODEL. Libagon.

Moreno-Guerrero, A.-J., Aznar-Díaz, I., Cáceres-Reche, P., & Alonso-García, S. (2020). E-Learning in the Teaching of Mathematics: An Educational Experience in Adult High School. *Mathematics, 8*(5), 840. https://doi.org/10.3390/math8050840.

Muhammad, A. H., & Musbah, K. T. (2013). Improvement Quality of LMS Through Application of Social Networking Sites. International Journal of Emerging Technologies in Learning (iJET), 8(3), 48. https://doi.org/10.3991/ijet.v8i3.2669

Pagtulon- an, E. & Tan, D. (2018). Students' Mathematics Performance and Self-Efficacy Beliefs in aRich Assessment Tasks Environment. Asian Academic Research Journal of Multidisciplinary,5(2),54-64

Powerschool. (2022, April 20). Retrieved from Powerschool Website: https://www.powerschool.com/blog/the-tpack-framework-explained-with-classroom-examples/#:~:text=TPACK%20is%20a%20technology%20integration,are%20very%20different%20in%20scope.

Research Clue. (2017). the effects of e-learning on teaching and learning of mathematical concepts. Available at: https://nairaproject.com/pro-jects/2669.html. [Accessed: 2023-9-7].

Saad, L. (2005, May 15). *Gallup.* Retrieved from Gallup, Inc. Website: https://news.gallup.com/poll/16360/math-problematic-us-teens.aspx

Sa'ad, T. U., Adamu, A., & M. Sadiq, A. (2014). The Causes of Poor Performance in Mathematics among Public Senior Secondary School Students in Azare Metropolis of Bauchi State, Nigeria. IOSR Journal of Research & Method in Education (IOSRJRME), 4(6), 32-40. https://doi.org/10.9790/7388-04633240

Saavedra, J. (2020). Educational Challenges and Opportunities of the Coronavirus (COVID-19) Pandemic. World Bank Blogs.

Salamat, L., Ahmad, G., Bakht, I., & Saifi, I. L. (2018). Effects of E–Learning on Students' Academiclearning at university Level. *Asian Innovative Journal of Social Sciences and Humanities, 2*(2), 1-12.

Strategies-for-Improving-Student-Retention.pdf. (2014). https://www.hanoverre-search.com/media/Strategies-for-Im-proving-Student-Retention.pdf

Segumpan, Lester Lou & Segumpan, Benguar & Tan, Denis. (2018). MATHEMATICS PER-FORMANCE AND ANXIETY OF JUNIOR HIGH SCHOOL STUDENTS IN A FLIPPED CLASSROOM. 10.5281/zenodo.1325918.

Spiteri, M., & Chang Rundgren, S.-N. (2018). Literature Review on the Factors Affecting Primary Teachers' Use of Digital Technology. *Technology, Knowledge and Learning, 25*(1), 115-128. https://doi.org/10.1007/s10758-018-9376-x

Sweller, J. (1988). Cognitive Load During Problem Solving: Effects on Learning. Cognitive Science, 12(2), 257-285. https://doi.org/10.1207/s15516709cog1202_4

Tan, D & Cordova, C. (2018). Mathematics Proficiency, Attitude, and Performance of Grade 9 Students in Private High Schools in Bukidnon, Philippines. Asian *Academic Research Journal of Social Sciences & Humanities 5*(2), 103-116.

Tobias, C. A., & Diego, C. V. (2022). Factors Predicting the Mathematics Performance of Grade 8 Students in the New Normal. *Asian Research Journal of Mathematics,* 287-300. https://doi.org/10.9734/arjom/2022/v18i11602

Tsinidou, M., Gerogianns, V., & Fitsilis, P. (2010). Evaluation of Factors That Determine Quality in Higher Education: An Empirical Study. *Quality Assurance in Education, 18,* 227-244. https://doi.org/10.1108/09684881011058669

Ulep, Soledad A., (2006). Good Mathematics Teaching Practices - in the making: a Philippine Experience. https://www.semanticscholar.org/paper/GOOD-MATHEMATICS-TEACHING-PRACTICES-IN-THE-MAKING%3AU-lep/a10d530879f5f247251d61d37a4edf4bcc5eb425

Valverde-Berrocoso, J., Garrido-Arroyo, M. del C., Burgos-Videla, C., & Morales-Cevallos, M. B. (2020). Trends in Educational Research about e-Learning: A Systematic Literature Review (2009–2018). *Sustainability, 12*(12), 5153. https://doi.org/10.3390/su12125153

Vellaichamy,K.(2019). A study on barriers in teaching Learning process of mathematics at Secondary standard level. Journal of Emerging Technologies and Innovative Research. 6(1). 352-356.

Wei, M. H., & Dzeng, H. (2014). A comparison study of math education and math performance between Asian countries and the United States. *Journal of Socialomics,* 3(02), 2167-0358. https://doi.org/10.4172/2167-0358.1000111

Yeh, C. Y. C., Cheng, H. N. H., Chen, Z.-H., Liao, C. C. Y., & Chan, T.-W. (2019). Enhancing achievement and interest in mathematics learning through Math-Island. Research and Practice in Technology Enhanced Learning, 14(1), 1-19. https://doi.org/10.1186/s41039-019-0100-9

Zumbrunn, S., Tadlock, J., & Roberts, E. D. (2011). Encouraging Self-Regulated Learning in the Classroom: A Review of the Literature. Metropolitan Educational Research Consortium (MERC), Virginia Commonwealth University.