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The use of digital tools in teaching general mathematics among senior high students

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Abstract

This quasi-experimental study sought to find out the difference on the level of academic performance of students who used online learning modules in General Mathematics for the second quarter during school year 2021-2022 with self-learning modules provided by DepEd. This study used a control group with 30 randomly selected students and experimental group with another 30 students that were purposively selected. The online learning modules utilized digital and online tools such as Kahoot, Seesaw, personalized tutorial videos uploaded in YouTube, Quizziz applications, which were used to improve online assessments, as well as PowerPoint presentations used as supplement materials. Quantitative data were collected through post-tests, which were analyzed in concordance with the qualitative data from the focus group discussion. The findings found that the students' academic performance in General Mathematics in the experimental group was satisfactory while the control group did not meet expectations. Furthermore, there is also a huge disparity in the academic performance between those who chose modular distance learning and those students who opted online distance learning. It can be concluded that the use of digital tools in teaching General Mathematics is effective. Hence, the use of online learning modules in teaching General Mathematics is recommended as it promotes better student learning.

Keywords:
Digital tools
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Online learning modules
Quasi-experimental study.

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1. Introduction

Educational institutions globally have seen substantial challenges that have transformed the academic landscape due to Covid-19. In the Philippines, Department of Education (DepEd) Most Essential Learning Competencies (MELCs) (2020) asserted that "Education must persist." Multiple learning delivery modes have been implemented to consistently provide quality education during this hard period. These encompass Modular Distance Learning, Blended Learning, and Homeschooling (Codamon, 2020). The Department of Education

issued Memorandum DM-CI-2020-000, entitled "Clarification on the Use of the Most Essential Learning Competencies (MELCs)". This served as the essential basis for all school departments and regional offices to integrate delivery modalities suitable for the local environment and learner variety while addressing the challenges posed by Covid-19.

Modular distance learning is a method of education that employs Self-Learning Modules (SLMs) aligned with the MELCS provided by the Department of Education (DepEd). Rodeiro and Nadas (2005) noted that one consequence of modularization is the restricted learning of topics across all subjects. This limitation arises because learners concentrate on a select few topics within each module, potentially relying on short-term memory. Consequently, students may forget other concepts due to insufficient exposure to the topics or lessons, resulting in a diminished opportunity for further learning through supplementary activities.

Online learning has revolutionized education by utilizing various resources like video tutorials, PowerPoint presentations, and assessment software. According to Hassan, Hassan, Dahalan, Zakaria, and Nor (2012) teachers must become proficient designers, content specialists, and technology experts to create effective online learning resources. A survey of math teachers in Makati City found a positive impact on students' performance, with 85% noticing an increase in attention and participation (De Velez, 2019). Meanwhile, Cortez (2020) study found that students' ability to participate in online learning sessions is unaffected by their lifestyle and available resources. The success of online education depends on learners' attitudes, priorities, and access to specific devices.

Misamis Occidental's Department of Education has started online distance learning for junior high school students, despite the majority coming from low-income families. Researchers are working to improve student learning quality. The principal's encouragement and challenges faced by teachers and students motivated the researchers to conduct a study in the second quarter to determine if there is a significant difference in academic performance between online and self-learning modules for General Mathematics instruction.

1.1. Modular Distance Learning (MDL)

Modular distance learning emphasizes personalized instruction, allowing students to employ self-learning modules (SLMs) in either written or digital format/electronic copy, depending on their preferences (Malaya, 2020). Students can also use learning materials such as resources for learners, textbooks, activity sheets, study guides, and other learning materials. In this learning mode, teachers can either send selected materials to pupils at home or access them by downloading electronic versions to their computer, tablet, or smartphone.

Sadiq and Zamir (2014) and Oparina and Rakova (2018) conducted research on the implementation of modular distance learning modality at the National University of Modern Languages and the Technical University. They drew conclusions from their statistical analysis and findings that because students learn at their own pace in this modular approach, it was proven beneficial in boosting students' knowledge as well as their understanding and critical thinking. Furthermore, a free self-learning approach was visible in which practice exercises were given quick reinforcement and feedback, which motivated the pupils and piqued their interest. Lastly, they discovered that using a modular strategy increased the likelihood of student engagement in completing the activities on the spot. As a result, pupils are free to learn in their own unique way.

1.2. Online Distance Learning (ODL)

According to Paulsen (2020) online distance learning was commonly connected to a lot of terms such as virtual education, internet-based education, web-based education, and education via computer-mediated communication. He also said that from the Web Education Systems Project, online learning described the separation of teachers and learners which distinguished it from face-to-face education. Likewise, ODL was also referred to as the influence of an educational organization which distinguished it from self-study and private tutoring. In other words, it is simply the use of a computer network to present or distribute some educational content. Consequently, it is the provision of two-way communication via a computer network so that students may benefit from communication with each other to the teachers and staff.

In addition, Stauffer (2020) clarified the meaning of online distance learning or e-learning where it was intended to be used with other person in teaching and learning method. Similarly, it is an alternative way of providing varied learning opportunities to students aside from classroom. With online distance learning, students and teachers could be in same setting in learning digital lessons and answering assessments. Furthermore, this modality also requires regular meetings with an in-person interaction between the teacher and the learners. Thus, it could be utilized as a blended learning strategy along with other learning modalities.

1.3. Digital Tools

The Department of Health and Social Care defines digital tools as programs, websites or online resources that can make jobs easier to accomplish. These are accessible in internet or web browsers both at home and in a workplace. Moreover, there is no need to download these tools in order to access instead, open the link or application to join in digital learning.

According to Kumar and Raja (2019) digital tools offered opportunities for promoting student creativity, student voice, and expanding where and how students learn. Thus, these tools helped the learners in enhancing

their skills and enthusiasm in working out with the tasks that were given by the teacher in a class scenario. Their active interests enabled them to fulfil their objectives in learning a specific field. This was supported with the response of one of the teachers in the study of Cox, Preston, and Cox (2019) which states, "when using digital tools, learners are not afraid in making mistakes, so they are more prepared and try more complex or harder work".

Some of the common digital tools that are available in a classroom setting include Google Classroom, Edmodo, ClassDojo, and Kahoot (Chauhan, 2018). In addition, Ekaran (2018) also mentioned some tech-based tools which include Seesaw and Khan Academy that can be used in managing digital classroom. Similarly, Modular Object-Oriented Dynamic Learning Environment (MOODLE) was also mentioned by Bartee (2016) which could also be used in customizing own learning environments. These are only some of the aid tools in digital learning that strike the motivation and interest of the young learners to continue their studies at home.

In line with this, the study of Perini (2015) revealed that digital tools offer a variety of modes of interaction between sessions in an academic community. He also concluded that social networking is indeed helpful in interacting with students even if both are off campus

1.4. Math Performance through Online Platforms

Academic performance is defined as the amount to which learners completed their short or long-term educational goals, according to a reference book published by IGI Global (2021). In other words, this is concerned with how learners approach their studies and how they cope with or complete the tasks assigned by their teachers. This also highlights the total scores achieved by distance learners, particularly in written assignments. Similarly, academic achievement at educational institutions is determined by a large list of evaluations (Bell, 2018). This indicates how capable the students are in meeting the local government and the institution's standards.

The majority of students at AMA College-Olongapo City believed that e-learning was extremely useful in terms of giving them time to undertake other courses or work at the same time when it was implemented in the researchers would like to thank the participants for their valuable time and acquaintance which supported this study tremendously. In earnest, it thanks the school administrators for their invaluable support and for allowing the research to be carried out in their institutions. Finally, the authors would like to acknowledge all the great people, including the regrets, encouragements, and contributions who have played a prominent role in completing this paper successfully.

mathematics. They even shared that the well-designed and user-friendly webpage made the learning easy especially in answering online activities. Moreover, the researchers in the study concluded that e-learning education system promoted a high productivity and enhanced learners' effectivity in learning and still needed improvement and more upgrades (Mobo & Sabado, 2019).

In connection, Abuhassna et al. (2020) discovered a positive and significant link between students' academic performance and online learning platforms, notably MOODLE and Learning Management System (LMS). On the contrary, Barkand (2017) found that there was no significant difference in students' academic performance when they used online platforms. This is due to the fact that academic achievement in relation to online learning platforms necessitates a specific set of skills and knowledge in order for such technology to be successful.

The researchers were inspired to employ digital resources as digital learning platforms in this study. Some of these digital tools include Google Classroom, researcher-created websites where individual modules in General Mathematics could be accessed, and YouTube, which included researcher-developed video tutorials in ODL. Additionally, the researcher used online evaluation tools such as Kahoot, Seesaw, and Quizizz to help students grasp the lectures or subjects in each module. The Google Classroom was the primary medium for conducting General Mathematics classes. As supplementary materials, PowerPoint slides were also provided.

Furthermore, the researchers intended to see if the claim made by Karal, Kokoc, Colak, and Yalcin (2015) was true that learning mathematics using an online modality promotes learner participation and leads to more teacher-student contact among Grade 11 students in the researcher's workplace. Furthermore, this research would want to investigate whether the conclusions of a US Department of Education study indicating digital learning platforms have a lower impact on students' learning amount and the researcher's context are consistent.

Accordingly, the researchers aimed to assess students' academic performance in ODL and MDL using post-test data from Grade 11 students in both modalities, with a maximum score of 100. Finally, the researchers examined whether there is a significant difference in academic performance between MDL and ODL students.

1.5. Statement of the Problem

The goal of this study was to determine the academic performance of Grade 11 students in online distance learning, which would be used to improve the researcher-developed online learning modules. Specifically, this study sought answers to the following questions:

1. What is the respondents' level of academic performance in General Mathematics in:
1.1. Modular Distance Learning; and
1.2. Online Distance Learning?

2. Is there a significant difference in the level of students' academic performance in General Mathematics between the students who choose modular distance learning and those who opt for online distance learning?
3. Based on the findings, what revised online learning modules may be proposed?

2. Method

2.1. Research Design

The usefulness of employing digital tools in teaching General Mathematics was investigated in this study, which used a quasi-experimental research methodology. In particular, in the experimental research design, this study used a two-group treatment design. The experimental group consisted of students who chose online distance learning using digital tools in General Mathematics and the control group consisted of students who used their self-learning modules. Respondents in the control group were chosen at random. However, the respondents in the experimental group were chosen on purpose since they needed to pass the Speed Test with at least 5 mbps to avoid disconnection during synchronous sessions. Many research variables were controlled, such as the teacher's skill in teaching, the lessons to be taught, the time of administration, and the respondents' grade level, to minimize threats to internal validity and biases. This study used digital tools like Google Classroom, YouTube and PowerPoint Presentations as well as assessment applications such as Kahoot, Seesaw and Quizizz for the experimental group.

2.2. Research Respondents

The participants in this study were 60 Grade 11 senior high school students in one of the DepEd secondary school in Misamis Occidental from all tracks and strands. According to Banerjee (2018) the minimum sample size in conducting statistical research is 30. Hence, the researchers considered 30 respondents in each group. In all 10 sections, thirty students from the control group were chosen at random using a lottery method. Purposive sampling was conducted among the remaining 30 online distance learning respondents. This was based on their interest and willingness to engage in the study through an assent letter signed by their parents and the result in Speed Test of having at least 5 mbps. This is supported by the Google Meet hardware requirements that, to have a high definition (HD) video quality during meetings online, 4 mbps is required for 10 participants. Since the experimental group has 30 participants, the researcher's standard set was 5 mbps to avoid disconnection during synchronous sessions scheduled twice a week.

2.3. Research Instruments

In conducting this study, three research instruments were used. The first was the five Self-Learning Modules (SLMs) in General Mathematics provided by the DepEd among the respondents in MDL. These modules were created by Regional Development Teams from Cagayan de Oro (CDO) City headed by Ludita S. Aljas as the author. The second was the researcher-developed online learning modules for the respondents in the experimental group. These consisted of the following parts: overview, module content, objectives, general instructions, pre-test, definition of terms, lessons, summary or key points, glossary, references, and post-tests. The researcher-developed websites were evaluated by one principal, two master teachers, one head teacher as content experts and one ICT expert in the school. The last instrument used in this study was the researcher-enhanced post-tests in every module with TOS that has a total of 100 items, 20 items per module. The tests covered the consolidated topics in five modules of the second quarter lessons. These contained the main concepts in Simple and Compound Interest, Annuities, Basic Concepts of Stocks and Bonds, Basic Concepts of Business and Consumer Loans, and Logic. These post-tests were evaluated by the same content experts.

2.4. Data Analysis

The respondents' raw post-test results from both the control and experimental groups were gathered. The mean score was used to calculate the average of post-test results in each group for measuring the degree of students' academic success. Because the data acquired were not normally distributed, the Mann-Whitney U test, as non-parametric test, was employed. This was used to reveal if there was a significant difference in students' academic performance between respondents in modular and online distance learning. Similarly, this determines whether online distance learning is better than modular distance learning.

3. Results and Discussion

3.1. Academic Performance of the Students in the Control and Experimental Groups

The scores of 60 Grade 11 students on their post-tests were recorded and analyzed. Thirty of the respondents in MDL took the post-tests through paper and pen. The rest of the 30 respondents in ODL answered the online post-test through Quizizz application. They were all included in the conduct of focus group discussion to gather their best learning and challenges or problems encountered in ODL.

Tables 1 to 8 show the academic performance of students in both groups in various General Mathematics modules. The scores generated are interpreted using the descriptors in the K to 12 grading system namely: Outstanding, Very Satisfactory, Satisfactory, Fairly Satisfactory and Did Not Meet Expectations.

Table 1. Students' level of academic performance in module 6.

Academic performance		Experimental group		Control group	
Score scale	**Descriptors**	**Frequency**	**Percentage (%)**	**Frequency**	**Percentage (%)**
18-20	Outstanding	6	20.00	0	0.00
17	Very satisfactory	5	16.67	0	0.00
16	Satisfactory	3	10.00	1	3.33
15	Fairly satisfactory	6	20.00	5	16.67
Below 15	Did not meet expectations	10	33.33	24	80.00
Total		30	100	30	100
Mean score		15.27		11.60	

Note: 17.50 – 20 = Outstanding; 16.50 – 17.49 = Very satisfactory; 15.50 – 16.49 = Satisfactory; 14.50 – 15.49 = Fairly satisfactory; Below 14.50 = Did not meet expectations.

In the experimental group, 11 out of thirty students, or 36.67%, had at least very satisfactory academic achievement, but none of the students in the control group did. In comparison to the control group, more students in the experimental group were able to comprehend the learning module on Simple and Compound Interest. This simply means that the students who utilized digital technologies in the online learning modality learned better than those using self-learning modules.

Meanwhile, it is also important to consider the lower end of the scores which belongs to did not meet expectations level. Ten out of 30 or 33.33% of the students in the experimental group scored below 15 while 24 out of 30 or 80% of the students in the control group got this score. This data show that many students who were utilizing the self-learning modules had much difficulty in recalling information or facts and understanding the concepts related to simple and compound interest. This resulted to their failure in the post-test. Hence, these students lacked mastery on these learning competencies and need improvement.

Moreover, the experimental group's post-test mean score of 15.27 is greater than the control group's post-test mean score of 11.60. This shows that the experimental group's academic performance in Module 6 is rather satisfactory, whereas the control group's academic performance did not meet expectations.

This was backed up by the FGD results, which showed that respondents #9, #10, #11, #14, #15, #20, #21, #22, #25, #27, #28 and #30 considered online as fine, great, amazing and enjoyable with the assistance of the subject teacher. This is supported by the statement of Cox (2019) that technology can make studying more enjoyable and integrating it in the classroom can improve student learning and engagement. Furthermore, according to Scharaldi (2020) the utilization of multimedia in online learning brings learning to life. As a result, it improved their drive and desire to learn General Mathematics in a fun and enjoyable way. This was attested by the respondents as they shared their enjoyable experiences in ODL.

> *At first, I feel a little bit nervous but at the end of the day I enjoyed it; it is definitely easy and I am so glad about it (Respondent #20).*
>
> *It is a good modality because I experience enjoyment, and I really learned something from the online learning modules we used (Respondent #27).*
>
> *I enjoyed the way of learning since there is an interaction of all my classmates and the activities are creatively presented; it motivates me to continue learning and I love it (Respondent #30).*

Additionally, respondents #11 and # 28 enjoyed most on the concepts of Simple Interest. This simply means that the increased involvement and engagement of learners in learning General Mathematics is because of the use of online learning modules. This study is consistent with findings reported in the study of Ni (2013) which concluded that online classrooms improve the quality and quantity of student interaction and participation. As a result, 60% of their respondents increased their engagement in online class work.

Table 2. Students' level of academic performance in module 7.

Academic performance		Experimental group		Control group	
Score scale	**Descriptors**	**Frequency**	**Percentage (%)**	**Frequency**	**Percentage (%)**
18-20	Outstanding	9	30.00	0	0.00
17	Very satisfactory	4	13.33	0	0.00
16	Satisfactory	5	16.67	1	3.33
15	Fairly satisfactory	6	20.00	2	6.67
Below 15	Did not meet expectations	6	20.00	27	90.00
Total		30	100	30	100
Mean score		16.37		10.43	

Note: 17.50 – 20 = Outstanding; 16.50 – 17.49 = Very satisfactory; 15.50 – 16.49 = Satisfactory; 14.50 – 15.49 = Fairly satisfactory; Below 14.50 = Did not meet expectations.

Table 2 reveals that 13 of the 30 students, or 43.33 percent, had very satisfactory and outstanding performance on their post-test in Module 7, which is about annuities, whereas no one in the control group achieved this level of performance. This means that students who used the online learning modules were able to grasp the concepts in Annuities, particularly when it came to solving word problems and recalling important facts and information.

On the other hand, only six out of 30 students (20%) in the experimental group had post-test scores below 15, compared to 27 out of thirty students (90%) in the control group. Because most of the students in the control group did not meet expectations, this indicates that they did not fully comprehend or master the learning concepts in Module 7. This necessitates the need of enrichment exercises in this lesson.

Meanwhile, the experimental group's mean score of 16.37 indicates that the students' academic performance was satisfactory, but the control group's mean score of 10.43 indicates that the students' performance did not meet expectations at all. It signifies that the majority of students in the experimental group grasped the lessons in Module 7. On the other hand, most of the students in the control group struggled with the lessons on annuity.

The FGD findings show that the digital technologies used in General Mathematics classes encouraged students to participate actively in the online session. According to Fulbrook (2020) some of the most considerable and influential digital tools are the online assessment applications such as Kahoot, Seesaw and Quizizz. Respondents enjoyed the online class because of these tools as they narrated.

> *I liked listening to YouTube videos, the lessons in the videos teach us specific concepts in each module; just replay immediately if you don't understand anything (Respondents #25).*
>
> *I appreciated the use of Quizizz in taking online tests because I am always considered as one in the top rank (Respondent #27).*
>
> *I liked best joining online assessments especially the activities using Kahoot and Seesaw where I enjoyed competing with my classmates (Respondent #28).*

Therefore, online tools enhance students' enthusiasm for learning and improve their academic performance in General Mathematics, as confirmed by Shieh (2012) findings and Stansfield, McLellan, and Connolly (2004) studies. These tools promote student engagement, enjoyment, and success, making online learning environments effective in improving academic performance.

Table 3. Students' level of academic performance in module 8.

Academic performance		Experimental group		Control group	
Score scale	**Descriptors**	**Frequency**	**Percentage (%)**	**Frequency**	**Percentage (%)**
18-20	Outstanding	8	26.67	0	0.00
17	Very satisfactory	5	16.67	4	13.33
16	Satisfactory	9	30.00	3	10.00
15	Fairly satisfactory	3	10.00	1	3.33
Below 15	Did not meet expectations	5	16.67	22	73.33
Total		30	100	30	100
Mean score		16.57		12.63	

Note: 17.50 – 20 = Outstanding; 16.50 – 17.49 = Very satisfactory; 15.50 – 16.49 = Satisfactory; 14.50 – 15.49 = Fairly satisfactory; Below 14.50 = Did not meet expectations.

Table 3 reveals that 13 out of 30 students (43.34%) in the experimental group achieved very satisfactory and outstanding academic performance on the topic Basic Concepts of Stocks and Bonds, whereas only four out of 30 (13.33%) in the control group did. This suggests that students who were exposed to the online learning modules achieved high and very high scores, demonstrating a higher degree of understanding than those who used the SLMs.

Meanwhile, only five out of thirty students (16.67%) in the experimental group did not meet expectations, compared to 22 out of thirty students (73.33%) in the control group who performed at the same level. This indicates that the majority of the students in the control group who used SLMs struggled to understand the lessons in Module 8. Overall, the experimental group's mean score of 16.57 indicates a very satisfactory level of academic performance, whereas the control group's performance did not meet expectations, with a mean score of just 12.63.

The FGD results revealed that students learned best on the basic concept of stocks and bonds where many students enjoyed so much while learning. Respondents #6, #9, #10, #17, #18, #20, #23, #24, #29 and #30 appreciated more the significance of the concepts of stocks and bonds in building big investments in the future as they uttered:

> *The concepts in stocks and bonds are very significant because it will help us someday to have a big investment; we will definitely get out of financial problems when there is an investment (Respondent #6).*
>
> *I realized that in the future, we could apply this topic on stocks and bonds whenever we have already big savings that are enough to be able to start a business soon (Respondent #17).*
>
> *Yes of course, I enjoyed in module 8, because I learned the meaning of stocks and bonds and that was very useful maybe not now but I believe someday I will apply all of that (Respondent #24).*

It can be deduced that students are exploring real-world applications of online learning modules, aligning with Fjelstul (2006) study that demonstrates improved academic performance through self-evaluations, discussion postings, and practice tests.

Table 4. Students' level of academic performance in module 9.

Academic performance		Experimental group		Control group	
Score scale	**Descriptors**	**Frequency**	**Percentage (%)**	**Frequency**	**Percentage (%)**
18-20	Outstanding	12	40.00	1	3.33
17	Very satisfactory	4	13.33	1	3.33
16	Satisfactory	2	6.67	2	6.67
15	Fairly satisfactory	8	26.67	6	20.00
Below 15	Did not meet expectations	4	13.33	20	66.67
Total		30	100	30	100
Mean score		16.67		11.87	

Note: 17.50 – 20 = Outstanding; 16.50 – 17.49 = Very satisfactory; 15.50 – 16.49 = Satisfactory; 14.50 – 15.49 = Fairly satisfactory; Below 14.50 = Did not meet expectations.

Table 4 shows that 16 out of 30 students in the experimental group achieved very satisfactory and outstanding academic performance on the topic Basic Concepts of Business and Consumer Loans, compared to only two out of 30 students in the control who achieved the same level of performance. This suggests that the majority of students in the experimental group were able to grasp the ideas of loans and master the learning competencies in Module 9 compared to only a few students in the control group.

On the other hand, the control group had 20 out of 30 students, or 66.67%, who receive a score of less than 15, indicating that their performance did not meet expectations. In the experimental group, however, just four out of thirty pupils (13.33%) did not meet expectations. This indicates that the majority of students in the control group were unable to comprehend the Module 9 lessons. They also lacked knowledge of the ideas and computing capabilities required to complete the module. The students in the experimental group had a mean score of 16.67, indicating that their academic performance in Module 9 was very satisfactory. The academic performance of the children in the control group, on the other hand, did not meet expectations, as evidenced by the mean score of 11.87.

The FGD results showed that 15 of the students asserted the usefulness of business and consumer loans in our daily lives and were able to express their enjoyment in learning this concept using online learning materials. In addition, respondents #7, #9, #10, #12, #13, #17, #20, #23, #24 and #30 enjoyed the simplicity of the concepts of business and consumer loans in online learning modality as they said.

> *I appreciated Business and Consumer Loans in Module 9 because it's easier than the lessons in the other modules (Respondent #7).*
>
> *I like most in Module 9 because I know now how to solve problems in business and consumer loans and also it is easy to identify whether it is business or consumer loan (Respondent #9).*
>
> *I had fun, and I enjoyed business and consumer loans because online learning is really the best (Respondent #12).*

In addition, respondents #13 and #24 appreciated the applications of Business and Consumer Loans in the field of investments as they articulated:

> *The best learning that I gained is the concept on Business and Consumer Loans because I want to build a business, soon for my family (Respondent #13).*
>
> *The best learning that I like in module 9 was all of the topics that we discussed earlier because I'm sure that someday I'll use or apply all of that in real life; I'm pretty sure that those lessons will be very useful in our daily lives (Respondent #24).*

In connection, the online learning modules on business and consumer loans aroused their interest, improved their knowledge, and even left an imprint on the hearts of the respondents in their future business careers.

The usage of online learning modules in General Mathematics is related to Spitzer and Musslick (2021) study, which found that closing schools in 2020 had a favourable influence on students' performance in an online math learning environment. They went on to say that learners who did poorly in 2019 seen recent gains in their academic performance due to the utilization of extra online learning tools.

Table 5 presents the distribution of students in terms of their academic performance in the post-test in Module 10 on the topic Logic. It shows that 11 of the 30 participants in the experimental group demonstrated very satisfactory and outstanding performance in Logic, while just one of the 30 (3.33%) achieved a very satisfactory level of performance in the control group. This means that students who used the online learning modules had gained better understanding compared to the students who were using the SLMs.

Moreover, the table also revealed that in the control group, 27 out of 30 students (90%) had academic performance that did not meet expectations, whereas in the experimental group, just six out of 30 (20%) had the same result. As a result, the usage of SLMs has a lower impact than the usage of online learning modules, which has shown higher student achievement in terms of their General Mathematics results. Furthermore, the

experimental group's academic performance was satisfactory, as evidenced by their mean score of 16.23, whereas the control group's performance did not meet expectations, as shown by their mean score of 9.90.

Table 5. Students' level of academic performance in module 10.

Academic performance		Experimental group		Control group	
Score scale	**Descriptors**	**Frequency**	**Percentage (%)**	**Frequency**	**Percentage (%)**
18-20	Outstanding	8	26.67	0	0.00
17	Very satisfactory	3	10.00	1	3.33
16	Satisfactory	4	13.33	0	0.00
15	Fairly satisfactory	9	30.00	2	6.67
Below 15	Did not meet expectations	6	20.00	27	90.00
Total		30	100	30	100
Mean score		16.23		9.90	

Note: 17.50 – 20 = Outstanding; 16.50 – 17.49 = Very satisfactory; 15.50 – 16.49 = Satisfactory; 14.50 – 15.49 = Fairly satisfactory; Below 14.50 = Did not meet expectations.

The FGD results showed that students learned best in Logic as respondents #13, #15, #17, #20, #23 and #24 were able to express that the Lessons 1 to 4 in Module 10 are related to English lessons on using logical connectives. At the same time, they enjoyed the concepts because some were easy to understand like describing simple and compound propositions. Moreover, respondents #1, #3, #4, #11, #12, #21, #24 and #25 considered the YouTube video tutorials as helpful in their learning where they evidently stated.

> *Watching tutorial videos added to my learning in the subject especially that Module 10 has 6 lessons (Respondent #11).*
>
> *I learned best through videos since I can replay the video if I am confused like in proving validity of arguments which is hard for me (Respondent #12).*
>
> *I liked listening to YouTube videos, the lessons in the videos taught us specific concepts in each module; it helped me answer my queries during the viewing (Respondent #25).*

Hence, Video tutorials enhance students' learning and performance in online General Mathematics modules, providing the freedom to replay concepts when needed, aligning with Lai and Zhu (2016) findings, especially among average learners.

Table 6 displays the distribution of students in terms of their over-all academic performance in General Mathematics in the second quarter. It can be gleaned from the table that the mean score of the experimental group is 81.10, while the control group's mean score is just 56.43. This demonstrates that the experimental group's academic performance is described as satisfactory, which is significantly better than the control group's performance which did not meet expectations. This indicates that using online learning modules in General Mathematics improved students' academic performance significantly as compared to using Self-Learning Modules (SLMs).

Looking into the details, none in the control group obtained at least very satisfactory level of academic performance while there were eight or 26.67% of the students in the experimental group who reached very satisfactory and outstanding performance in General Mathematics in the second quarter. This result signifies that online learning in General Mathematics with integration of some appropriate digital tools enhances student learning. Students learn better or gain better understanding of the mathematics concepts when lessons are delivered online compared to SLMs which is most used and adapted by majority of the students.

Table 6. Students' level of academic performance in general mathematics in the second quarter.

Academic performance		Experimental group		Control group	
Score scale	**Descriptors**	**Frequency**	**Percentage (%)**	**Frequency**	**Percentage (%)**
90-100	Outstanding	6	20.00	0	0
85-89	Very satisfactory	2	6.67	0	0
80-84	Satisfactory	10	33.33	1	3.33
75-79	Fairly satisfactory	8	26.67	4	13.33
Below 75	Did not meet expectations	4	13.33	25	83.33
Total		30	100	30	100
Mean		81.10		56.43	

Note: 17.50 – 20 = Outstanding; 16.50 – 17.49 = Very satisfactory; 15.50 – 16.49 = Satisfactory; 14.50 – 15.49 = Fairly satisfactory; Below 14.50 = Did not meet expectations.

On the other hand, only four or 13.33% of the students in the experimental group did not meet expectations or failed in the second quarter compared to 25 or 83.33% of the students in the control group who were on the same level of performance.

Table 7. Mann-Whitney U test result of both groups in modules 6-10.

Module no.	Group	N	Mean rank	U-value	z	ρ	r
6	Control	30	21.17	170	-4.162	<0.001	0.54
	Experimental	30	39.83				
7	Control	30	17.32	54.5	-5.874	<0.001	0.76
	Experimental	30	43.68				
8	Control	30	20.37	146	-4.534	<0.001	0.59
	Experimental	30	40.63				
9	Control	30	19.43	118	-4.949	<0.001	0.64
	Experimental	30	41.57				
10	Control	30	17.30	54	-5.885	<0.001	0.76
	Experimental	30	43.70				

3.2. Significant Difference Between the Performance of the Students in the Control and Experimental Groups

As shown in Table 7, the mean ranks among 30 students in the experimental group are higher than the mean ranks among 30 students in the control group. Noticeably, the students in the experimental group who utilized the online learning modules had higher mean ranks (43.68 and 43.70) in Modules 7 and 10 compared to the control group (17.32 and 17.30). This implies that those students who chose online learning modality had higher level of academic performance in General Mathematics compared to those who opted modular distance learning modality especially on the concepts of Annuities and Logic. Thus, it is revealed that the online learning modules developed in each module contributed a lot in improving students' conceptual and problem-solving skills and thus provide satisfaction among the learners. Furthermore, the use of the online learning modules in Modules 6 to 10 signifies its positive effect to the retention of mathematical concepts in all topics and to the development of students' computational and problem-solving skills.

It can be deduced from the table that the r value ranges from 0.54 to 0.76 indicates that the academic results of students in the control and experimental groups are moderately and highly correlated. As a result, with a sample size of 30 in each group, the test for significant difference is reliable.

In relation to the aforementioned statement, the U values obtained from Modules 7 and 10 (54.5 and 54) denotes that there is a substantial difference between the level of students' academic performance in the experimental group and the control group compared to Modules 6, 8 and 9. It means that the lessons on Annuities and Logic indicate a higher significant difference in the academic performance of the students who utilized online learning modules compared to the other group who used self-learning modules in these specific concepts.

Moreover, for a two-sided test with significance level $\alpha = 0.05$, the critical value is $z_{1-\alpha/2} = 1.96$. It can be gleaned from the table that the absolute values of z are greater than the critical value of 1.96 which signifies that the null hypothesis should be rejected. This result is further supported by the value of p in the table which is less than 0.001 and is definitely a small value which means that the difference between the level of academic performance between the two groups is significant. Additionally, the smaller p value also tells to reject the null hypothesis. The study found significant differences in students' academic performance on Simple and Compound Interest, Annuities, Stocks and Bonds, Business and Consumer Loans, and Logic concepts between control and experimental groups, indicating the importance of online learning modules for future usage.

The study found that online instructional modules incorporating videos on differentiation, integration, and vector calculus significantly improved post-test scores in an intervention group compared to a control group. The intervention group saw a 13% increase in post-test scores, while the control group remained unchanged. The quality of the modules was highly satisfactory, and 70% of the intervention group's students showed positive attitudes towards the modules, indicating the effectiveness of online teaching methods.

Table 8. Mann-Whitney U test result in the performance of both groups.

Group	N	Mean rank	U-value	z	P	r
Experimental	30	43.17	70	-5.631	<0.001	0.73
Control	30	17.83				

As seen in the table, the absolute value of z, which is 5.631, is more than the critical value, which is 1.96. This means that the null hypothesis, that there is no significant difference in students' academic performance in General Mathematics between those who chose modular distance learning and those who chose online distance learning, was rejected. This conclusion is backed up by a p value of less than 0.001, which is clearly a smaller number that implies rejecting the null hypothesis. The r value of 0.73 indicates that the students' performances in both the experimental and control groups are highly correlated. This also means that the post-tests used to compare the academic performance of students in both groups are quite dependable.

Table 9 further shows that the U value (70) indicates that there is a significant difference between the post-test outcomes of students who are exposed to online learning modules and students who are exposed to self-

learning modules. As a result, the experimental group's raw scores had a higher mean rank (43.17) than the control group's (17.83). This indicates that students who used online learning modules performed much better academically than those who utilized SLMs. This also shows that students in the ODL had better or higher academic performance than students in the MDL, implying that the online learning modules have the potential to increase students' General Mathematics performance. As a result, using digital tools to teach General Mathematics is a good idea. This result is consistent with the findings of Moradi, Liu, Luchies, Paterson, and Darban (2018) who found that online instructional modules improved post-test performance, with students expressing engagement and positive survey results.

Table 9. Post-test results in each module in the experimental group.

Online learning module	Mean score	Descriptors
Module 6: Simple and compound interest	15.27	Fairly satisfactory
Module 7: Annuities	16.37	Satisfactory
Module 8: Basic concepts of stocks and bonds	16.57	Very satisfactory
Module 9: Basic concepts of business and consumer loans	16.67	Very satisfactory
Module 10: Logic	16.23	Satisfactory

3.3. Bases for the Enhancement of the Online Learning Modules

Although the academic performance of students in the experimental group is significantly higher than that of students in the control group, Table 10 shows that academic performance levels range from fairly satisfactory to very satisfactory, indicating that there is still room for improvement on their part. The students were then asked for their thoughts for improving the online learning modules so that they might be improved further and made ready for usage in the following school year.

Table 10. Suggestions of the respondents in the online learning modules.

Online learning module	Suggestions from the respondents
Module 6: Simple and compound interest	The explanation on compound interest in the video tutorial must be detailed enough to be understood
Module 7: Annuities	Examples in deffered annuity must be explained well since some are confusing
Module 8: Basic concepts of stocks and bonds	The topic is interesting about business and the online learning module does not need to be improved.
Module 9: Basic concepts of business and consumer loans	The topic is still about investments and the module is enough to be learned
Module 10: Logic	Lessons 4-6 in the video tutorials must be improved to have clear explanations on the concepts

Table 10 presents respondents' suggestions for improving online learning modules integrating digital tools, particularly in mathematics, where students often struggle with interpreting compound interest problems, suggesting detailed explanations. In line with this, there are 11 of the students who revealed their weaknesses in solving word problems on compound interest as they said.

> *I don't like answering difficult word problems especially in Module 6; it is not easy for me to find its solution, but our teacher is always approachable to help us understand all the topics (Respondent #19).*
>
> *Honestly, I don't like the topic in Module 6 which is about solving problems on compound interest because I find the steps difficult to follow (Respondent #23).*

Clearly, the students were struggling when it comes to answering worded problems in compound interest as also experienced by previous students in learning General Mathematics. Hence, the explanation and discussion on the video tutorial in compound interest was revised to address their concern regarding this module. The FGD results also showed the difficulty of the students in solving word problems on deferred annuity in Module 7 where they suggested that this concept must be explained well since it is confusing sometimes. Regarding this, there are eight of the students who experienced this problem while learning General Mathematics as they expressed.

> *I have difficulty with problem solving in deferred annuity, but Ma'am CJ is willing to help me (Respondent #2).*
>
> *I don't like in learning module 7 since some of the problems in deferred annuity are really hard for me to solve and some of the examples are quite difficult to understand (Respondent #5).*

Evidently, students manifested their difficulties experienced in understanding deferred annuity. Hence, the explanation in the video instruction was changed to reflect the issues raised by the students.

In contrast, 15 respondents expressed their contentment on the utilization of online learning lessons in Module 8. This included the topic on the basic concepts of stocks and bonds where they articulated.

> *For me, there is nothing to change in Module 8 since I like the online activities than the modular one (Respondent #1).*

The online learning module in Module 8 is informative already because through it, one can learn the subject thoroughly compared to printed modules (Respondent #17).

The online learning module in stocks and bonds is good enough for me because as a student, they can already explore on the different activities through engagement because the activities are not the same; they were made in different perspectives and are better than self-learning modules (Respondent #27).

This is definitely an indication that they were able to compare online learning from their previous experience in modular set up. With this, Module 8 retained its content and structure. A coinciding result in the study of Johnson (2008) supports that student who used online modules scored higher on the final examination than students who do not. Similarly, it is evident that students enjoyed the business lessons in Module 9 as they uttered.

The online learning module in business and consumer loans are already enough to learn a lot of things in General Mathematics, especially in investments (Respondent #12).

I like the best in Module 9 about Business Loan because we are taught to become successful investors someday (Respondent #20).

They emphasized that more learning will be gained in viewing the online learning modules in the concepts, specifically in investments. In addition, nine students underlined the pleasurable and fun experiences in Module 9, while four students stated that enjoying the online learning module is also an important motivator for doing well and learning well. As a matter of fact, their best experiences were expressed as they shared.

Module 9 is okay for me because there are tutorials and I super enjoyed the online test. (Respondent #2).

I just love the online learning module on investments because it's very enjoyable and interesting and I love it (Respondent # 28).

In line with this, the encouragement and motivation of young learners in business are sustained through their interest and love in the concepts on investments. Evidently, students are contented in their online learning experience.

Meanwhile, there were five students who encountered difficulty in some concepts of logic in Module 10. These concepts fall under Lessons 4 to 6 in Module 10 namely, rewriting verbal sentences to symbolic forms, truth tables, and validity of arguments. This statement is evident from the lines of the students where they said.

I don't like learning module 10 especially in lesson 6 because I don't really know what exactly means about the topic, I don't totally get it (Respondent #5).

What I don't like in Module 10 is the making of a truth table (Respondent #20).

Making sentences in symbolic form was the part of module 10 that I dislike because it's difficult for me to make a sentence in symbolic form due to my lack of mastery of the rules (Respondent #24).

Students struggled with the last module's six lessons, focusing on higher order thinking skills, but seven used digital tools and online learning modules to independently learn argument validity. On the contrary, some students expressed their difficulties encountered after utilizing digital tools where they articulated.

By browsing the PowerPoint presentations provided by Ma'am CJ or watching her YouTube videos, the topic on validity of arguments is still difficult for me (Respondent #21).

I watch the YouTube tutorials in truth tables and listen to the discussion in our synchronous session but understanding this lesson is still difficult for me; I read and analyze the steps again and again but it's really difficult (Respondent #29).

This signifies that the digital tools are not enough for them to understand the aforementioned concept. Therefore, the tutorial videos on the concepts of rewriting verbal sentences to symbolic forms, truth tables, and validity of arguments were further improved as to address the difficulties of students in understanding these concepts.

4. Conclusion

The study suggests that online learning modules in General Mathematics, incorporating digital resources like video lessons and assessment programs, can effectively support online learning. These modules help students understand basic concepts of stocks, bonds, business, and consumer loans, while also ensuring students enjoy learning and promoting health in the new normal education mode.

5. Recommendations

The following suggestions are made based on the preceding observations and results.

1. The enhanced online learning modules may be used in teaching Grade 11 learners in General Mathematics especially in heterogeneous classes to ensure better level of academic performance.
2. Teachers may be given training workshops during Learning Action Cell (LAC) sessions on the use of online instructional materials for them to gain mastery on the integration of technology in online classes.
3. Although innovations mean added workloads to teachers, they may be motivated and encouraged to prepare and use online instructional materials to sustain motivation, interest, and enjoyment of learners in all classes especially in Mathematics and Science subjects which students consider difficult. For the teachers who are implementing modular distance learning, they may modify or enhance the SLMs provided by DepEd to make the activities easy to follow by students.

4. A follow-up study may be conducted as the enhanced online learning modules for second quarter in General Mathematics is implemented to determine its effectiveness until the prepared modules reach its perfection.
5. Future researchers may replicate this study by utilizing students from other grade levels and evaluate modules from other topic areas.

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