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Programmed Module Instruction on Learners' Performance and Collaborative and Critical Thinking Skills in General Mathematics

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Abstract

This quasi-experimental research design aimed at finding out the effects of a researcher- made programmed module instruction to the learners' mathematics performance and collaborative skills and critical thinking skills in General Mathematics. The Researcher-made instruments, namely: Performance Test, Critical Thinking Skills Test, Collaborative Activity, FGD, and journal entry were the data sources. Statistical tools such as frequency, rank, mean, and standard deviation were used for descriptive analysis and t-test for independent samples, t-test for paired samples, and Pearson's r for inferential analysis. All inferential statistics were set at .05 level of significance. Results showed that after the intervention, the learners' mathematics performance was at a 'Proficiency level" and critical thinking skills improved to "Moderately Strong". There was no significant difference in the mathematics performance and critical thinking skills of learners before exposure to non-programmed module instruction and programmed module instruction. There was, however, a significant difference in the mathematics performance and critical thinking skills of learners after exposure to non-programmed module instruction and programmed module instruction. There was also significant difference in the learners' mathematics performance, critical thinking skills, and collaborative skills before and after exposure to non-programmed module instruction and programmed module instruction. No significant correlations existed between mathematics performance and critical thinking skills, between mathematics performance and collaborative skills, and between critical thinking skills and collaborative skills. Although no relationships were noted among the three variables, the computed r was positive after the intervention in both groups; hence there was still an association. Finally, the programmed module gave enjoyment, motivation, clear and simplified approach in presenting the lesson; encouraged the learners to work independently using computer; and offered valuable instructional material for learners.

Keywords: programmed module instruction; critical thinking skills; collaborative skill; mathematics performance.

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1. Introduction

Today, teachers search for the best teaching strategies that will improve the performance of learners in general mathematics. Implementing Rules and Regulations (IRR) of Republic Act No. 10533, otherwise known as the Enhanced Basic Education Act of 2013, Rule II Section 10.2, adheres to prescribed standards and principles, when appropriate, in developing the enhanced basic education curriculum that is learner-centered and uses pedagogical approaches that are constructivist, inquiry-based, reflective, collaborative, and integrative [1]. The lack of critical thinking skills utilized in the classroom greatly diminishes the learners' chance for success. The purpose of this research was to identify gaps in the students' understanding of information, quantify their ability to compose their knowledge of the material, and to enable students to understand the material enough to create an insightful question showcasing their comprehension of the material [1]. Leongson (2003) opines that Filipino learners excel in knowledge acquisition but fare considerably low in lessons requiring higher-order thinking skills. [1]. This disappointing condition is evident in the performance of learners in national and international surveys on mathematics and science competencies. The Third International Mathematical Science Study (TIMMS, 2000) examined patterns of learners' achievement in mathematics and found out that school effectiveness and teacher competency impact learning and promote higher level of achievements. Quality of instruction and effective instructional design are necessary to alleviate problems related to teaching and learning mathematics [1]. The unavailability of learning materials is just one of the problems still hounding the country's new basic education program, K to 12, in three years of its implantation. Instructional materials enhance the teaching/ learning process by exhibiting information necessary to acquire knowledge and skills. The acquisition of basic vocational knowledge, skills, and attitudes to facilitate occupational efficiency requires skill-oriented teaching and learning activities. Over the years, the poor performance of learners in public examinations has been blamed on the wrong choices of teaching methods by teachers. Teachers use different instructional materials to motivate learning. Success in the skill and knowledge acquisition in an instructional situation depends on the suitability, adequacy, and effective utilization of the available instructional materials. Also, the relevance of instructional materials to the objective of the lesson and the ease of use of the instructional materials are serious considerations in instructional materials utilization to improve learners' performance. With technological advancements in place, innovative pedagogies can be expected as a consequence of their applications in education. "Technological development has led us to develop different modernized techniques for innovative pedagogies in various technical fields may they be education, business, or distant learning. Focusing on computer's role in addressing Alternative Frameworks among learners in science (Social Development Theory), Vygotsky's idea of MKO (More Knowledgeable Other) gives an opportunity for a computer to interact with the learner and contribute to his learning with respect to a particular task or process. Specifically, if it is an alternative framework, a computer may be seen as a non-attacking More Knowledgeable Other. Thus, ZPD (Zone of Proximal Development) in this model is the distance between a learner's ability to "perform a task under computer guidance and support" and ability to "perform the task independently" [1,2].

2. Materials and Methods

This study used the quasi-experimental method and control group design. Considering such factors as internal validity and external validity of this experimental study, it was expected that the results of the study coul confirm the result of treatment-based learning problem. It ascertained which teaching strategy in mathematics was more effective the one that exposes the students to the use of programmed module instruction in teaching or the teacher discusses the concepts to the learners using lecture instruction [2]. In this study, an intervention or treatment, in the form use programmed module instruction was introduced to the experimental group only, and the control group had usual lessons with the use of non-programmed module instruction. After the treatment, a second round of observations or posttest was made. It was expected that since the experimental group received the treatment, significant change should manifest in this group, not in the control group. This method of research was considered best fitted in the present research undertaking, considering the fact that the study was to determine the difference in the students' performance before and after using the programmed module instruction among the Grade 11 senior high school learners.

The subjects of the study were the 80 Grade 11 senior high school learners of Rufino G. Palabrica Sr. National High School in Dingle, Iloilo, during the schoolyear 2019-2020. Of the 80 subjects, 40 belonged to the non-programmed module instruction group and 40 to the programmed module instruction group.

The fishbowl method was employed by the researcher in selecting the two groups as subjects of the study from the five strands enrolled in General Mathematics 11. The technique was done in this manner: five strips of paper representing the 5 strands were placed inside a box. Then, two strips of paper were simultaneously drawn to represent the two groups that were included in the study.

The learners as subjects for Focus group Discussion (FGD) came from the Programmed Module Instruction group. Selection was done through fishbowl method of the 40 learners, only eight were selected as representatives of the group to validate the response of the whole group regarding their experiences from their exposure to the said intervention. The researcher-made test was used to gather the extent of the learner's performance in mathematics. This research instrument originally consisted of 75 test items on functions. Table of Specifications (TOS) was made prior to the construction of the test to proportionate the number of items to the topics. In doing so, the researcher gave importance to the following: the learning objectives or content of the topic in a semester, time allotment of the whole semester, and the expected number of test items to be constructed. The initial draft of the Performance Test was submitted for face-and-content validation to a jury of three experts in mathematics and test construction. The jury's comments and suggestions were presented to the dissertation adviser before the instrument was finalized. Revision of the performance test was done in order to incorporate the suggestions and comments from the three experts. Upon approval from the adviser, it was pilot tested to Grade 11 STEM learners in another high school. The data gathered were computer-processed, tabulated, analyzed, and interpreted using appropriate Statistics. For analysis, the researcher used a scale of means and corresponding interpretations to determine the learners' performance in mathematics, both in the pretest and posttest. DepEd Order No.73 s. 2012 shows the general guidelines for Assessment and rating of learning outcomes for the K to 12 to measure the performance of learners. To evaluate each component of critical thinking skills of mathematics, the researcher used a critical thinking skills assessment rubric which was adapted from D.O No.73, s. 2012. Collaborative rubrics was used for learners' group activities. The researcher adapted the rubrics from DepEd Order NO. 73, s. 2012 in terms of product or output of learners. The researcher had given an activity problem consisting of 4 to 5 items to each group for individual assessment by their members using a Group Task Rubric or Self-Assessment Rubric. Comparing and sharing the reflections of learners during mathematics class and interview protocol utilized during the focus group discussion (FGD) were used to determine the experiences of the learners through writing their own journal on the use of program module instruction as instructional material in General Mathematics [4]. The experimental treatment was done for 7 weeks and divided into three stages: pre-experimental, experimental, and post-experimental. During the pre-experimental stage, the two groups were chosen to make sure that they were almost the same in terms of academic performance and sex. Preparation of programmed module instruction was done with the information Technology (IT) expert. The preparation of mathematics performance test and higher-order thinking skills test were also done together with the lesson plan and validated by three experts in the field of mathematics. After the validation of the lesson plan, the researcher incorporated the comments and suggestions for revision. The researcher conducted an orientation for the programmed module instruction group before the 7-week intervention and sent necessary letters for permission to conduct the study. Pre-tests for Mathematics Performance Test and Critical Thinking Skills were administered to the two groups. The learners in the experimental group were exposed to programmed module instruction. During the experimental stage, the programmed module instruction, the two groups were exposed to the same lessons and references; they differed only in the teaching approach to which they were subjected. Since the intervention took place only during the mathematics class, the programmed module instruction group used computer. Thereafter, the researcher evaluated them to assess their learning from the said intervention. The learners were scored individually.

During the post-experimental stage, at the end of the seven-week period, the learners in both groups were given a posttest to determine their Mathematics Performance and Critical Thinking Skills. The data gathered were computer-processed, tabulated, analyzed, and interpreted using appropriate statistical tools. For analysis, the researcher used the scale of means and corresponding interpretations to determine the learners' performance in mathematics, both in the pretest and the posttest. Thematic analysis was used to identify, analyze, and report patterns within data.

After the conduct of the experiment, the data were gathered, organized, tabulated, computer-processed, and interpreted using the Statistical Package for the Social Sciences (SPSS) software version 20 and qualitative data analysis. The quantitative data gathered for this study were subjected to appropriate computer-processed statistics via the Statistical Package for the Social Sciences (SPSS) software. Level of significance was set at 0.05. Means were used to describe the learners' performance in General Mathematics and Critical Thinking Skills in both pretest and posttest of non-programmed module and programmed module instruction groups. Mean was also used to determine the Collaborative Skills of the learners after the seven-week period. Standard Deviation was used to determine the dispersion of the scores of the subjects from the mean. The t-test for dependent samples was used to determine significant of difference in the Mathematics Performance Test and Critical Thinking Skills Test of the learners in the programmed module instruction group and non-programmed module instruction group before and after the intervention. The t-test for independent samples was used to determine significant difference in the pretest and posttest scores for the groups exposed to programmed module instruction and non-programmed module instruction group in teaching mathematics. Pearson's Product Moment Correlation Coefficient was used to determine the relationships among the Mathematics Performance Test, Critical Thinking Skills Test, and Collaborative Skills the learners were after exposed to programmed module and non-programmed module instruction. Thematic Analysis is a method for identifying, analyzing and reporting patterns within data [5]. In this study, it was used to describe the learning experiences of the learners during the intervention.

Learner's interview was conducted through written journal reflection and oral form. Results of the written interview were tabulated; oral interview was conducted to ascertain further views of learners about programmed module instruction. Responses to the oral interview were recorded, transcribed, and analyzed.

In this study, thematic data analysis was primarily used to interpret the results from the interview conducted to elicit the learners' feedback on their exposure to programmed module instruction. This is a qualitative analytic method for identifying, analyzing, and reporting themes within the data gathered. It also minimally organizes and describes data set details. Bracketing, delineating units of meaning, clustering to form themes, and extracting general and unique themes were the process involved in analyzing data derived from the Focus group Discussion (FGD).

3. Results

The descriptive findings of the study show the mathematics performance and critical thinking skills of the learners before and after their exposure to non-programmed module instruction and programmed module instruction. The result obtained by the learners through their pretest and posttest scores during the conduct of the study. For this, means and standard deviations were employed.

Table 1 shows the mathematics performance of learners in their pretest-posttest scores and critical thinking skills before and after exposure to non-programmed module and programmed module instruction. As shown in the Table, the mathematics performance of learners assigned to programmed module instruction in pretest (M =15.43, SD =3.05) and non-programmed module instruction (M =14.95, SD =3.13) is "Developing" at the outset of the intervention. "Developing" refers to the level of learners possessing minimum knowledge and skills and core understandings but needing help throughout the performance of authentic task assessments. The two standard deviations indicate that the values are closely dispersed under the mean. However, the performance of learners exposed to programmed module instruction in the posttest is "Proficient" (M=30.83, SD=2.88) while that of the learners exposed to non-programmed module instruction is "Approaching Proficiency" (M=27.45, SD= 3.05). Proficient refers to the level of learners' development of fundamental knowledge and skills and core understanding and can transfer them independently through authentic performance assessments. Approaching Proficiency refers to the level of learners' development of fundamental knowledge and skills and core understanding and, with little guidance from the teacher and/ or with some assistance from peer, can transfer these understanding through authentic performance assessments. This means that the use of programmed module instruction enhanced their learning compared to the learners in non-programmed module instruction. Hence, the standard deviation in the programmed module indicates that the values are closely dispersed above the mean while the standard deviation in non-programmed instruction indicates that the values are closely dispersed around the mean.

This result is confirmed by Chen, (2006), that programmed instruction is desirable as instructional strategy than lecture method based on the scores of students. With the modernization of societies, people have become more concerned about systematized teaching-learning techniques and training about different topics in different fields (Barik & Mondal, 2010). Table 2 further shows that the critical thinking skills of the learners under programmed module instruction prior to the intervention is “Very Weak” (M = 2.60, SD =1.41); the same is true for non-programmed module instruction group (M =2.68, SD =1.00). “Very weak” refers to learners who can barely demonstrate analytical processing of information and strive to perform processes such as interpret, translate express the information, draw insights, see beyond the data, read between the lines, reason logically and coherently. The two standard deviation indicates that the values are closely situated below the mean while the posttest results of learners in programmed module instruction is “Moderately Strong” (M=15.25, SD=1.41); the same is true for non-programmed module instruction group (M=13.93, SD= 1.85). “Moderately Strong” refers to learners who demonstrate fairly analytical processing of information and can perform with some competence processes such as interpret, translate express the information, draw insights, see beyond the data, read between the lines and reason logically and coherently. The two standard deviations indicate that the values are closely situated above the mean.

In the study entitled “Studying the Relationship between Critical Thinking skills and Students’ Educational Achievement” critical thinking is one of the important effective factors in academic achievement. Indeed, learners with critical thinking learn more abilities and competencies which improve their effectiveness [7].

Table 1: Mathematics Performance and Critical Thinking Skills of the Learners before and after their exposure to Non-Programmed Module Instruction and Programmed Module Instruction.

Category	n	SD	Mean	Descriptive Rating
. Programmed Module Instruction				
• Mathematics Performance				
Pretest	40	3.05	15.43	Developing
Posttest	40	2.88	30.83	Proficient
• Critical Thinking Skills				
Pretest	40	1.41	2.60	Very Weak
Posttest	40	1.41	15.25	Moderately Strong
B. Non-Programmed Module Instruction				
• Mathematics Performance				
Pretest	40	3.13	14.95	Developing
Posttest	40	3.05	27.45	Approaching Proficiency
• Critical Thinking Skills				
Pretest	40	1.00	2.68	Very Weak
Posttest	40	1.85	13.93	Moderately Strong

Note: The description was based on the indicated scale.

For mathematics performance: Advanced (40.01- 50.00); Proficient (30.01- 40.00); Approaching Proficiency (20.01 -30.00); Developing (10.00 -20.00); less than 10, Beginning

For critical thinking skills: Strong (16.01 - 20.00); Moderately Strong 12.01 - 16.00); Developing (8.01 - 12.00); Weak (4.01 - 8.00); Very Weak (1.00 - 4.00).

Table 2 shows that the collaborative skills of learners for both programmed module instruction (M =15.48, SD =1.77) group and non-programmed module instruction group (M =14.45, SD =2.26) are "Strong". This implies that the learners in both groups were motivated to perform collaboratively because they enjoyed the activities. Sometimes, the activities can be done outdoors. The two standard deviations indicate that the values are widely scattered around or above the mean. BIn the study of Bernero (2000), the students who struggled with mathematics continued to stress and strain about it and became discouraged with individual work but improved both academically and socially when it came to group work, due to an increase in their self-assurance. Group work interaction helped all members learn concepts and problem-solving strategies, improve their self-confidence, and overcome their fear of mistakes [8].

Table 2: Collaborative Skills of the Learners after Their Exposure to Non-programmed Module Instruction and Programmed Module Instruction

Category	n	SD	Mean	Descriptive Rating
Collaborative				
Programmed Module Instruction	40	1.77	15.48	Strong
Non-programmed Module Instruction	40	2.26	14.45	Strong

Table 3 shows that the pretest scores of learners in the mathematics performance test for programmed module instruction (M=15.42) and for non-programmed module instruction (M=14.95) are not significantly different

Note: The description was based on the indicated scale.

For collaborative skills: Strong (16.01- 20.00); Moderately Strong (12.01- 16.00); Developing (8.01- 12.00); Weak (4.01- 8.00); Very Weak (1.00 - 4.00)

with the t (78) = 0.688, p>0.05. This means that before the intervention started, the learner's mathematics performance in both groups are comparable. The pretest scores of learners in their critical thinking skills revealed that for programmed module instruction (M=2.60) and for non-programmed module instruction(M=2.68) are not significantly different; with the t (78) = 0.281, p>0.05. This implies that before introducing the lesson on functions, the learners under the programmed module instruction and non-programmed module group had more or less the same level of knowledge about the lessons. This indicates that both groups are comparable in terms of inferring, understanding, and evaluating.

This result is parallel to the study of Gokhale entitled "Collaborative Learning Enhances Critical Thinking and Mathematics Performance "(2000); a t-test was conducted on pretest scores for the two treatment groups. The mean of the pretest scores for the participants in the group that studied collaboratively was not significantly different from that the group that studied individually. Hence, it was concluded that pretest differences among treatment groups were not significant. Furthermore, in the study conducted by Udeh, (2017) entitled “Programmed Instructional Method of Teaching on Student Interest in Mathematics”, there was no significant difference before the intervention in teaching programmed instruction [8].

Table 3: Difference in the Mathematics Performance and Critical Thinking Skills of the learners before Exposure to Non-programmed Module Instruction and Programmed Module Instruction

Category	n	Pretest Mean	df	T	Sig. (2-tailed)
Mathematics Performance					
Programmed	40	15.42	78	0.688	0.494
Non-programmed	40	14.95			
Critical Thinking Skills					
Programmed	40	2.60	78	0.281	0.784
Non-programmed	40	2.68			

Table 4 shows the posttest scores of learners under programmed module instruction (M=30.83) and under non-programmed module instruction(M=27.45) are significantly different with t (78) =-5.091, $p<0.05$. After seven weeks of intervention, the performance of learners in the programmed module instruction improved. The improvement could be attributed to their exposure to program module instruction. The posttest scores of learners in critical thinking skills after the intervention exposed to programmed module instruction (M=14.90) and exposed to non-programmed module instruction (M= 13.90) are also significantly different with t (78) = -3.888, $p<0.05$.

The results revealed that the post test scores of learners exposed to programmed module instruction was significantly higher in mathematics performance and critical thinking skills test than those of learners under the non-programmed module instruction. It is true that mathematics performance replicates critical thinking skills p-value but in considering cohen’s d effect size, the magnitude of the effect obtained was almost identical. The study has the same effect regardless of p -values in terms of their mathematics performance and critical thinking skills because they have the same sample size. Cohen’s d result implies the large effect between programmed module instruction and non-programmed module instruction in terms of mathematics performance; the same is true in their critical thinking skills.

The study entitled “Using Technology Tools in the Public-School Classrooms” suggests that for technology to be effective and make changes in students' grades, motivation, attitude, and attendance, schools must be prepared for technology use in the classroom. Leaders must develop a model of implementation that includes a shared vision by teachers and leaders and the involvement of the entire school community. They must also make available consistent and specific training for staff, time during the school day for the training, a full-time technology director, and time for the staff to communicate and share with peers for technology to be an effective tool in the classroom curriculum. Results of the study indicated that teachers' technology use, students' technology use, and overall technology use depend on how well the teacher uses the technology in the classroom [9]. This result is parallel to the study entitled “The Effect of Technology on a Student’s Motivation and Knowledge” that technology has the potential to be a powerful educational tool for those that have interest in it. Students with no interest in using technology, will still benefit educationally from traditional methods. There have to be interest and motivation is using technology in the first place for students to succeed. As with any instructional topic, technology needs to be taught and embraced at an early age. If students are taught to hate technology at an early age, then their disdain for technology may follow them into their later years [10].

Table 4: Difference in the Mathematics Performance and Critical Thinking Skills of the Learners after Exposure to Non-programmed Module Instruction and Programmed Module Instruction.

Category	N	Posttest Mean	Df	T	Sig. (2-tailed)	95% Confidence Interval Lower	Upper	Cohen’s d
A. Mathematics Performance								
Programmed	40	30.83	78	-5.091*	0.000	-4.69	-2.06	0.99
Non-programmed	40	27.45						
B. Critical Thinking Skills								
Programmed	40	14.90	78	-3.888*	0.000	-1.51	-0.49	0.80
Non-programmed	40	13.90						

Note: *p<0.001

The t-test results in Table 5 shows that a significant difference existed between the pretest (M=15.42) and the posttest (M=30.83) scores of the learners prior to and after their exposure to programmed module instruction (t (39) = 25.58, p<0.001). As observed, the learners’ performance highly improved in the posttest. This improvement could be attributed to their exposure to module programmed in the computer in teaching mathematics. The use of this module increased the scores of the learners in their performance test in General Mathematics and helped them to participate, be independent, and explore during the hands-on using computer.

Results entitled “Integration of Programmed Instruction into Mathematics and Science Teaching: Panacea to Students Dwindling Interest in Mathematics and Science” showed that programmed instruction is desirable in many instructional settings because it provides immediate knowledge and feedback, and enhances individualized learning in mathematics instruction. Since the result showed a significant difference, therefore programmed instruction has importance in the learning of mathematics. This study was conducted in response to the need to establish evidence as to how programmed instruction can contribute to learning [10, 11]. Also, the t-test results revealed a significant difference between the pretest (M=2.60) and posttest (M=14.90) scores for critical thinking skills of the learners exposed to programmed module instruction t (39) = 43.91, p<0.001. As observed, the learners' higher-order thinking skills highly improved in the posttest. This improvement in their inferring, understanding, and evaluating level could be attributed through their exposure to module programmed in the computer in teaching mathematics. Significance is constructed by learners. The value therefore of teaching programmed module instruction to determine its significance to motivate learners could improve their critical thinking skills. However, it is worthy to note that the mathematics performance ($t(39)=21.13$, $p<0.001$) and critical thinking skills ($t(39)=44.12$, $p<0.001$) of the learners under non-programmed module instruction significantly improved after the intervention. This result implies that marked improvement was also observed in the mathematics performance and critical thinking skills of the learners using non-programmed module instruction. It is true that programmed module instruction replicates non-programmed module instruction p-value before and after their exposure, but in considering Cohen's d effect size in their mathematics performance, the magnitudes of the effect obtained are almost identical regardless of the p -values because they have the same sample size. Cohen's d describes the small effect between programmed module instruction and non-programmed module instruction before and after their exposure in terms of mathematics performance. It is true that programmed module instruction replicates non-programmed module instruction p-value before and after their exposure but in considering Cohen's d effect size in their critical thinking skills, the magnitudes of the effect obtained are almost identical regardless of the p -values because they have the same sample size. Cohen's d describes the medium effect between programmed module instruction and non-programmed module instruction before and after their exposure in terms of critical thinking skills. This result is parallel to the study entitled "The Effects of Technology Instruction on the Academic Achievement of Students", that no statistically significant difference existed between the use of the whiteboard and technological methods of instruction. The teacher in this study embraced technology and integrated it into instruction. However, the results of the study determined that neither the whiteboard nor the technological method of instruction affected students' academic achievement. The author found that his findings did not meet his expectations. They expected the students who received technological instruction to outperform those that received traditional instruction. There was no significant difference between the two classes. On one assessment, the traditional class scored higher. Ricer, Filak, and Short (2005) in their study in the field of science with medical students, compared technological instruction with traditional instruction. As in this research study, the authors did not find a statistically significant difference between the assessment scores of the groups that received technological instruction and those that received traditional instruction [11, 12].

Table 6 shows that there is a significant difference in the collaborative activity scores of learners exposed to programmed module instruction ($M=15.47$) and non-programmed module instruction ($M=14.45$) with $t(78) = -2.26$, $p<0.050$. The result implies that collaborative skills are more evident among learners under programmed module instruction than in the non-programmed module instruction after the intervention. As observed, the learners exposed to programmed module instruction were more active in participating in every collaborative activity during the seven weeks of intervention than the learners in the non- programmed module instruction. Furthermore, the use of computer during the discussion of the lesson brought a positive impact to the learners during collaborative activities. Instructions and guidelines were clear and easily seen in the programmed module, so they could start immediately the activity on time. This module offered complete presentation and the teacher simply serves as facilitator of learning.

Table 5: Difference in the Mathematics Performance and Critical Thinking Skills of the Learners before and after Exposure to Non-programmed Module Instruction and Programmed Module Instruction.

Category	N	Mean	df	T	Sig. (2-tailed)	95% Confidence Interval Lower	Upper	Cohen's d
A. Mathematics Performance								
• Programmed Module Instruction								
Before After	40	15.43 30.83	39	25.58*	0.000	14.18	16.62	0.43
• Non-programmed Module Instruction								
Before After	40	14.95 27.45	39	21.13*	0.000	11.30	13.70	0.33
B. Critical Thinking Skills								
• Programmed Module Instruction								
Before After	40	2.60 14.90	39	43.91*	0.000	11.73	12.87	0.69
• Non-programmed Module Instruction								
Before After	40	2.67 13.90	39	44.12*	0.000	10.71	11.74	0.70

*Note: *p<0.001*

It is true that programmed module instruction replicates non-programmed module instruction p-value after their exposure, but in consideration of Cohen's d effect size in their collaborative skills, it describes the medium effect between programmed module instruction and non-programmed module instruction after their exposure in terms of collaborative skills because they have the same sample size. As Van Boxtel and his colleagues (2000) explain, collaborative learning activities allow students to provide explanations of their understanding, which can help students elaborate and reorganize their knowledge. Social interaction stimulates elaboration of conceptual knowledge as groupmates attempt to make themselves understood, and research demonstrates that providing elaborated explanations improves student comprehension of concepts. Once conceptual understanding is made visible through verbal exchange, students can negotiate meaning to arrive at a convergence, or shared understanding [13]. This result is confirmed by Alkaabi (2016) that there were significant differences in the scores of students who undertook collaborative learning with the same learning style in a blended learning environment due to their learning style and traditional style of teaching, being associated with significantly higher scores.

The results revealed that there was no significant relationship between mathematics performance and critical thinking skills for both groups after the intervention. Pearson's Product Moment Correlation Coefficient results show that 6% of the variance in the learners' mathematics performance can be explained by critical thinking skills of learner's exposed to programmed module instruction; therefore, no significant positive correlations existed between mathematics performance and critical thinking skills ($r=0.245$, $p= 0.128$). On the other hand, 6% of the variance in learners' mathematics performance can be explained by critical thinking skills exposed to non-programmed instruction ($r=0.248$, $p=0.123$).

Table 6: Difference in the Collaborative Skills of the Learners after Exposure of Non-programmed Module Instruction and Programmed Module Instruction

Category	N	Mean	Df	t	Sig. (2-tailed)	95% Confidence Interval Lower	Upper	Cohen's d
Collaborative Skills								
Programmed Module Instruction	40	15.47	78	-2.26*	0.027	-1.93	-0.12	0.50
Non-Programmed Module Instruction	40	14.45						

Note: *p<0.050

The results imply that although the relationship between mathematics performance and critical thinking skills is not significant, the computed r is positive after the intervention for both groups; hence, there is still association between learners' mathematics performance and critical thinking skills. However, there was a low R-squared value in both groups. This is normal since study habits of learners are factors that can enhance learning in mathematics and are attributed to their performance.

Further, Morgono and his colleagues (2017) study entitled "The Relationship between Higher-Order Thinking Skills and Academic Performance of Student in Mathematics Instruction" found a strong positive relationship between two variables, HOTS and GPA. Furthermore, on the test p-value, a very strong evidence is shown to suggest that there is a linear correlation between the two variables, HOTS and GPA. Based on the correlation coefficient and the p value, it can be stated that the higher the HOTS, the higher the GPA will be. The higher the students' HOTS, the higher the GPA they will get [14].

The results revealed that there was no significant relationship between collaborative skills and critical thinking skills for both groups after the intervention. Pearson's Product Moment Correlation Coefficient results show that 7% of the variance in the learners' collaborative skills can be explained by critical thinking skills of learners exposed to programmed module instruction; thus, no significant positive correlations existed between collaborative skills and critical thinking skills ($r=0.270$, $p= 0.092$). On the other hand, 4% of the variance in learners' collaborative skills can be explained by critical thinking skills exposed to non-programmed instruction ($r=0.205$, $p=0.205$).

The results imply that although the relationship between collaborative skills and critical thinking skills ids not significant, the computed r is positive after the intervention for both groups; hence, there is still an association between learners' collaborative skills and critical thinking skills. However, there was a low R-squared value in both groups. This is normal since the participation of learners in their group during activities could not affect their critical thinking skills test result.

The results also revealed that there was no significant relationship between mathematics performance and collaborative skills for both groups after the intervention. Pearson's Product Moment Correlation Coefficient results show that 3% of the variance in the learners' mathematics performance can be explained by collaborative skills of learner's exposed to programmed module instruction; thus, no significant positive correlations existed between mathematics performance and collaborative skills (r=0.158, p= 0.731). On the other hand, 2% of the variance in learners' mathematics performance can be explained by collaborative skills exposed to non-programmed instruction (r=0.137, p=0.399).

The results imply that although the relationship between collaborative skills and mathematics performance is not significant, the computed r is positive after the intervention for both groups; hence, there is still an association between learners' collaborative skills and mathematics performance. However, there was a low R-squared value in both groups. This is normal since the participation of learners in their group during activities could not affect the mathematics performance test.

Table 7: Relationships between Mathematics Performance, Critical Thinking Skills and Collaborative Skills after Exposure to Programmed Module Instruction and Non-programmed Module Instruction

Variables	r-value	r^2	Sig
A. Critical Thinking Skills & Mathematics Performance			
• Programmed Module Instruction	0.245	0.060	0.128
• Non- programmed Module Instruction	0.248	0.062	0.123
B. Critical Thinking Skills & Collaborative Skills			
• Programmed Module Instruction	0.270	0.073	0.092
• Non- programmed Module Instruction	0.205	0.042	0.205
C. Collaborative Skills & Mathematics Performance			
• Programmed Module Instruction	0.158	0.025	0.331
• Non- programmed Module Instruction	0.137	0.019	0.399

Note: p>0.05

The study participants in this group were exposed to using offline computer during their class session and they were instructed to observe the teaching –learning situation on how this strategy could help them in learning mathematics. The feedback and opinions of student-participants underwent thorough discussion using thematic analysis. The researcher transcribed and typed the data into a computer file, in order to analyze it after interviewing. Interviews during focus group discussion (FGD) were particularly useful in uncovering the story behind the participants' experiences and pursuing in-depth information around a topic. Open-ended questions were asked during interviews in the hope of obtaining impartial answers, while close-ended questions may force participants to answer in a particular way [15]. Thematic Analysis is a flexible data analysis that a qualitative researcher easy may find to follow but rigorous enough to generate meaningful findings from the data. The goal of thematic analysis is to identify patterns or themes in the data that are interesting and important and use these themes to address the research or say something about an issue. A common pitfall is to use the main interview question as the theme. Typically, this reflects the fact that the data have been summarized and organized, rather than analyzed (Braun & Clarke, 2013).

During the conduct of Focus Group Discussion (FGD) the answers of the student-participants were observed and transcribed. First, exploring the programmed module instruction using offline computer can motivate them to study and work independently. Second, they can save the programmed module in their own laptop, cellphone, and USB for follow-up and review purposes during free time or at home. Third, they can watch downloaded video clip about the lesson to understand thoroughly the subject matter. Fourth, they enjoy seeing graphics and pictures during the collaborative activities in which the teacher serves as a facilitator of learning.

It was found out that the learners exposed to programmed module instruction had the opportunity to experience different ways of learning mathematics. As millennials, they could explore and maximize learning using offline computer. It was very timely that the learners were exposed to e-classroom in the discipline, especially in mathematics; through it, they navigated the computer, scanned the previous topics, and practiced solving some problems.

In qualitative studies, human investigation is the primary instrument for the gathering and analyzing of data. Lincoln and Guba (1985) introduced the concept of human as instrument to emphasize the unique role that a qualitative researcher plays in inquiry. Because qualitative research studies human experiences and situations, researchers need an instrument flexible enough to capture the complexity of the human experience, an instrument capable of adapting and responding to the environment.

The researcher transcribed the answers of the learners after conducting the Focus Group Discussion (FGD) and checking thoroughly in their journal. The following patterns or themes of their answers were formulated to analyze the qualitative parts of this study. Program Module Instruction gives…

Learning is Enjoyable. Enjoyment is understood as the state or process of taking pleasure in something. Therefore, it is assumed that learners would show greater interest and satisfaction when the lecture in the process of programmed module instruction, is conducted with humor. It is also believed that taking pleasure in learning is one of the conditions of having outcomes. So, the teaching process can be supported by humor, because it has the potential to humanize, illustrate, defuse, encourage, reduce anxiety, and simply keep learners thinking. The experimental group in this study enjoyed the interactive visualization of a module programmed in the computer. Enjoyment plays a big role in learner's learning experiences because a high level of enjoyment is linked to higher engagement during the learning process as well as increased interest and motivation. (Hernick & Jaworska, 2018). Students' interest has become a point of focus of researchers in mathematics education and it has been pointed out that students' attitude and beliefs about mathematics are strongly related to their learning outcomes and success in mathematics [15].

Learner 4 said that, "I really enjoyed learning mathematics with this programmed module instruction, although mathematics is not so easy subject, but it provides us meaningful experience using computer. This is the way for those students to have an easier and accessible in learning because it can view anytime."

Learner 23 said that, "for me its enjoyable because all of us use computer individually and we are free to explore the lessons in general mathematics."

During the exposure of learners to programmed module in the computer, their sense of engagement was observed by the teachers. They felt belongingness in every session of their lesson without hesitation in participating in the activities. Since mathematics is not an easy subject to learn, learners were not pressured; however, they enjoyed exploring the programmed module solely and independently.

Mathematics lessons are more interesting. The purpose and importance of motivation should be clearly understood by the teacher. The fundamental aim of motivation is to stimulate and facilitate the learning activity. Learning is an active process that needs to be motivated and guided toward desirable ends. It is important to attempt to get the learner into a state of readiness for it increases the alertness, vigor, and wholeheartedness of learning. The teacher must be continually on the alert to perceive these differences and fluctuations. Since all learners do not react similarly, the motivation of learning must be varied for different individuals. An understanding of the nature of motivation is important because motivation determines not only the intensity of the effort to learn but also the extent to which this effort is made an activity of the total personality. Motivation of learning using programmed module instruction helps the learners to concentrate on what he or she is doing, and thereby gain satisfaction. Continuous motivation of a teacher is needed to help learners concentrate on the lessons to be learned. Learner 7 said that, "it is interesting because of the videos presented in each topic, serves as tutorials."

Learner 4 said that, "we find it more interesting because we still have time to study and review the module anytime, anywhere."

Learning takes place if learners are motivated in every session of their classes. After the seven-week intervention, almost all learners were present and punctual in attending the class compared to other group without exposure to programmed module instruction. This observation, it was found out that learners are motivated and interested the lesson using the intervention. Millennials nowadays were very explorative, and they can learn easily using technology, specifically computer.

The lessons were conveyed easier and clear. Clarity for learning offers a simple and doable approach to develop clarity and sharing it with learners. With the ever-changing landscape of education, teachers and learners often find themselves searching for clarity in a sea of standards, curriculum resources, strategies in teaching, and competing priorities. In this study focus was on the teaching strategy of the teacher on how to deliver the lesson effectively to the learners. Presenting the lesson to the learners with clear concepts of the subject matter and with instructional materials like programmed module could enhance learning. Instructional materials are defined, according to Olumorin, Yusuf, Ajidagba, and Jekayinfa, (2010), instructional materials in their simplest term were those materials that facilitate the teachers to teach with ease and the learners to learn without stress. Instructional materials appeal to the sensations of seeing, touching, sensing, and hearing. While a teacher's job does not end in managing the classroom, planning and evaluating, instructional materials have a big part in the teaching-learning process.

Learner 1 said that, "the use of programmed module instruction helps me to learn mathematics more easily and clearly because we all have a computer to have closer view of the lesson and it is very clear to be read."

Learner 30 said that, "it gives new technique of teaching that brings simple and easy to understand in presenting the examples of each lesson that suited to digital native learners."

Learner 11 said that, "for me programmed module instruction is more accurate and effective because it presents easy and properly sequence of lesson."

The learners were able to learn the topics because the lesson is presented in a very simple approach through programmed module instruction. If they could not understand the lesson, the learners were able to watch the video clip in every lesson to understand each topic.

It facilitated independent learning. Being able to work independently is a skill highly valued by learners exposed to program module instruction. Independent learning does not mean working on one's own; but rather, one may find that he/she shares a problem with another learner during the collaborative activity. Working with someone else, encouraging each other, and talking through difficulties may be the most effective way of working independently. Explaining a concept to someone without shared background knowledge is a very good way of making sure one understands the full implications of the concepts through exploration of a module in the computer. In the study by Bernero (2000), the students who struggled with mathematics continued to stress and strain about it and became discouraged with individual work but improved both academically and socially when it came to group work, due to an increase in self-assurance.

Learner 15 said that**,** "it's very hard to trained me to understand the lesson alone but it helps us to work independent because everyone has a computer to focus in study alone the lesson."

Learner 14 said that, "through it, I can study without the help of my classmates and it develops personal understanding of the lesson."

Learner 30 said that, "it is highly individualized instructional strategy that helps student learning by doing."

The learners concluded that in every topic presented in programmed module instruction, they learned independently using the computer. The advantage of having a computer laboratory in school can be a great help to them not only in mathematics but also in other disciplines.

The use of instructional material in class is innovative. One area of focus is managing and promoting learning inside the classroom. How teachers utilize instructional materials is an issue. Indeed, qualifications and resources are not the only factors that influence teachers' effectiveness; equally important are teacher's motivation, commitment, resourcefulness, innovativeness, and creativeness in dealing with instructional materials. A lack of these things will produce poor attendance and unprofessional attitudes towards learners. In today's situation, the teacher needs to prepare innovative instructional materials to avoid such problems. To be innovative, a teacher must be resourceful with new strategies to encourage learners to focus on the lesson, the reason why the researcher made this programmed module instruction for the millennial learners wherein technology is the best medium of instruction. Bawa, N. (2016) defines Instructional material as anything a teacher uses in teaching and learning situation from small stones, pieces of paper, small sticks, a sample of a leaf, chalkboard, maps, charts, radio, television, computers. According to Olayinka, (2016), the importance of instructional materials in the development of learners' intellectual abilities and attainment of teaching/learning objectives cannot be overemphasized.

Learner 1 said that, "programmed module instruction is one method of our teacher and serves an important innovation as an instructional material in teaching- learning process."

Learner 7 said that, "the techniques are readily in hand using computer that draw a wide variety of supplemental innovations or even replace traditional way of learning."

The use of programmed module instruction was very useful to the learners. It served as innovative instructional material that can help the learners understand well the lesson so that the teaching-learning process is enhanced. Table 9 shows the summary of themes.

4. Conclusions

Using programmed module instruction in teaching General Mathematics in Grade 11 seems to improve the learners' performance scores. For technology-oriented learners, a programmed module can be learned using computer, it is useful as instructional material, and offers an interesting and meaningful learning experience to today's millennials. However, the programmed module instruction should be considered by the teacher as a strategy in teaching learners since it is already proven to be effective in enhancing learners' performance.

Understanding and fostering the ability to help learners think critically is essential to their educational success. Facilitating the development of critical thinking skills is crucial to address on a continual basis through various lessons, projects, group problems, and/or individual assignments. A positive way to distinguish the growth of critical thinking skills within the classroom is to empower students to take a more active role by writing a minute paper at the end of class or a particular lesson.

The small difference in the means of both groups implies that some learners in programmed module instruction were perhaps motivated to perform collaboratively within the group because they enjoyed the activities using the computer.

The use of programmed module instruction as a learning tool appears as an effective strategy in teaching the subject by significantly raising the mathematics performance scores of the learners. The increase in the learners scores is an important indicator of learning effectiveness.

After the intervention, the learners' critical thinking skills improved using the module programmed in the computer. The exploration of the learners to open again the previous lesson for review purposes to familiarize themselves with and practice answering the problems seems to have enhanced their critical thinking skills, thus the significant result after the study.

Incorporating the collaborative learning skills in a programmed module instruction can help learners develop motivation because working with others often triggers situational interest and curiosity. A significant result revealed after the intervention is shown in the scores of the learners. With collaborative learning, team members work interactively together on the same task. Collaboration can have positive effects on student learning, especially for low-achieving students.

The relationship among mathematics performance, critical thinking skills, and collaborative skills were not significant; specifically, no significant positive correlations between mathematics performance and critical thinking skills, between mathematics performance and collaborative skills, and between critical thinking skills and collaborative skills since the mean scores of both groups were probably in same range regardless of the intervention.

After the eight-week intervention, the programmed module instruction appears to have motivated them to study and work independently, save the programmed module in their own laptop, cellphone, and USB for follow-up and review purpose as they enjoy seeing graphics and pictures in the computer and doing the collaborative activities in which the teacher serves as facilitator of learning. Finally, the programmed module offers enjoyment, motivation, and clear and simplified approach in presenting the lesson, encourages the learners to work independently using computer, and is a valuable instructional material for learners.

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-Mother Teresa

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