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Phenomenon-based Conversational Microlesson Packets on Students' Mathematics Achievement and Appreciation

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Abstract This study aimed to determine the effectiveness of Phenomenon-Based Learning Conversational Microlesson Packets (PBCMPs) learning material to the mathematics achievement and appreciation among Grade 7 students, who are officially enrolled during the School Year 2021-2022 at Maria Cristina National High School, Iligan City. Two sections with 31 students each class were used as participants of the study and randomly selected as control and experimental groups which employed a pretest-posttest control group research design. The level of mathematics achievement of students was measured using the validated 30-item mathematics achievement test (MAT) and the mathematics appreciation of the students was measured using their scores in taking the Mathematics Interest Inventory (MII). Mean, standard deviation, and the analysis of covariance (ANCOVA) were used to analyze the data collected. Results revealed that embedding phenomenon-based learning into the developed PBCMPs learning material helped develop the students' mathematics achievement and appreciation. Hence, integration of phenomenon-based learning in any mathematics learning material is recommended to help uplift students' achievement and affective state in learning mathematics. Furthermore, similar studies may also be conducted to a broader scope using various population in different learning institutions for refinement of the method.

Keywords: *phenomenon-based learning, microlesson, interest-driven creator theory, self-learning material, distance learning*

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1. Introduction

Mathematics is one subject that pervades life at any age and in any circumstance. Thus, its value goes beyond the classroom and the school. Therefore, mathematics as a school subject, must be learned comprehensively and with much depth. In the Philippine education curriculum, one of the twin goals of mathematics in the basic education levels is to develop the problem-solving skills of students to improve students' mathematics achievement [1].

However, one of the internal factors that may influence the students' ability to solve mathematical problems is their lack of appreciation in mathematics. Students with a low appreciation in mathematics have tendency to be inactively engaged in the learning process. While students with high appreciation of mathematics gives them motivation, spirit, and confidence that they will be able to understand the mathematical materials and that they can solve mathematical problems [2]. Further, students have automatic generated perception that mathematics is abstract and so the learning would yield them no benefit which eventually leads them to nevermore appreciate the beauty of mathematics [3].

In this study, mathematics appreciation refers to students' affective state or interest of being engaged in mathematics learning whereby students enjoy the learning process while mathematics achievement refers to the significant gain of the students' scores in the pretest and posttest.

Based on experience, it has always been a challenge for mathematics teachers to improve students' mathematics achievement and to make them appreciate the subject during face-to-face learning. More so with the current global health crisis wherein schools were prompted to implement a range of distance learning modalities to support students continued learning, including online platforms, TV and radio programming, and take-home print packages due to school closures [4].

The presence of teachers in students learning process is highly important as they greatly helped in facilitating students learning [5]. But due to limited facilitation of teachers in distance learning, the goals of uplifting students' achievement and appreciation towards mathematics have become overwhelming.

In the Philippines, self-learning modules (SLMs) have become the primary instructional materials being utilized in the Department of Education [6]. The use of modules encourages independent study. Students engage themselves in learning the concepts presented in the module. They develop a sense of responsibility in accomplishing the tasks provided in the module. With little or no assistance from others, the learners progress on their own. They are learning how to learn [7].

A well-designed self-learning material can be a hallmark for a successful modular distance learning [8]. In addition, the design of the lesson in the learning materials would be more meaningful and relevant to the students' lives by relating the students' context to mathematical content taught in school [9]. Thus, with the main ideology of incorporating real-life events to students' learning process, the design of the material would integrate the phenomenon-based approach, as it has received wide interest and publicity in the field of education [10]. Phenomenon-based learning (PhBL) encourages students to connect learnings to the real-world context and learn through understanding what they are doing. This concentrates on the learners' learning rather than the teacher's teaching [11]. However, in the Philippines, very few studies have been conducted in relation to phenomenon-based learning since it is an approach originated in Finland in the year 2015.

Thus, the researchers were prompted to embed phenomenon-based learning into the developed learning materials called phenomenon-based conversational microlesson packets (PBCMPs) to improve the student's mathematics achievement and appreciation.

Specifically, the main objective of this research was to determine the effectiveness of embedding phenomenon-based learning into the developed PBCMPs learning material to students' mathematics achievement and appreciation. These self-learning materials aimed to accelerate more meaningful students' learning experiences promoting profound learning and helping the students relate the concept to real-life since the activities and problems to be presented are familiar to them as these are naturally anchored in real-world phenomena.

1.1. Theoretical Framework

This study is anchored on the principle of Interest Driven Creator (IDC) theory. The IDC theory proposes that stimulating curiosity is one of the processes in triggering interest. To elicit interest, teachers or instructional designers should scaffold knowledge deficit, which subsequently can help students be immersed or fully engaged in the learning process by providing optimum levels of challenging learning tasks [12]. In relation to mathematics learning, students' interest can be promoted by firstly presenting a mathematical problem that is able to provoke and confront students' prior knowledge, and scaffold students to tackle challenges that help students gain successful experiences and finally present the practical value of the learning content [13].

With this idea, this study is driven to incorporate the principle of Phenomenon-Based Learning (PhenoBL). PhenoBL is a holistic, learner-driven approach to learning where "phenomena" are studied as complete entities, in the real context. These phenomena provide a starting point for the learner to learn the information and skills related to them [14]. Thus, phenomenon-based approach is anchored learning, where the questions asked and issues to be learned are naturally anchored in real world phenomena, and the information and skills to be learned can be directly applied across borders between subjects and outside the classroom in situations where the information and skills are used [15]. The PhenoBL approach to teaching and learning invites us to break the boundaries of traditional subject teaching and move toward interdisciplinary explorations of phenomena [16]. PhenoBL actively involves students in hands-on activities aimed at answering questions and solving problems, in contrast with passive, rote memorization curricula of the past. Moreover, Phenomenon-Based Learning (PhenoBL) is not built on a strict set of rules. The essential part of the process is student's active role in creating an understanding of the phenomenon [17]. Thus, in PhenoBL students are not passive recipients of lessons, but proactive participants, contributing to and learning from the topic.

Hence, these literatures could give ideas on how to integrate phenomenon-based learning in the design of the developed phenomenon-based conversational microlesson packets to help develop students' mathematics achievement and to provoke students' affective state of interest or appreciation in learning mathematics.

2. Methodology

2.1. Research Design

The study used the pretest-posttest control group design to determine the effects of phenomenon-based learning activities embedded in the phenomenon-based conversational microlesson packets (PBCMPs) learning material to students' mathematics achievement and appreciation. This involves the experimental group and control group which was carefully selected through randomization process. The experimental group was exposed to treatment which utilized the researchers' developed PBCMPs learning material while the control group utilized the final version of DepEd alternative developed module materials.

2.2. Respondents

The participants of the study were the two intact classes of Grade 7 students who were officially enrolled during the school year 2021-2022 at Maria Cristina National High School. Two sections with 31 student-participants each was randomly assigned as the experimental group and the other as the control group. Each section was heterogenous in nature and the student-participants are approximately of the same age ranging from 12-13 years old.

2.3. Instruments

The validation of the developed phenomenon-based conversational microlesson packets was determined using a 5-point Likert scale adapted from the Department of Education. 30 in-service mathematics teachers had evaluated the PBCMPs.The results showed that the developed phenomenon-based conversational microlesson packets learning materials have passed the criteria set by the Department of Education in the Philippines based on the three major areas: content (99.60%), lay-out and design (99.51%) and language (99.63%).

A teacher-made 30-item mathematics achievement test (MAT) was employed to measure the students' level of mathematics achievement. The test was constructed using a table of specifications, face validated by mathematics experts, and pilot tested on students who had successfully finished learning the mathematical concepts of concern from the previous grading period. Cronbach's alpha (α=0.811) suggested that the outcome was reliable, with thirty (30) items out of forty retained.

The Mathematics Interest Inventory (MII) comprising 27 items which was originally developed by Stevens and Olivárez (2005) was used to measure students' level of mathematics appreciation. MII is a 7-point Likert scale, ranging from 1 (not at all true of me) to 7 (very true of me), which was used for all items in this instrument. There are 11 reversed items in the instrument, specifically items 11 to 20 and item 26. These negatively stated items were reverse scored before the scores were computed at the data analysis stage. The reliability of the MII was established with Cronbach's alpha value at 0.82 which is categorized as highly reliable as cited in the study of Shu Ling Wong and Su Luan Wong (2019).

2.4. Data Gathering Procedure

The researchers carefully followed the ethical procedures in the conduct of the study. Since the study has been conducted during the COVID19 crisis, permission was requested from the principal of the participating school and consents from parents/guardians of the student-respondents to come to school for face-to-face assessments were also asked prior to the experimentation.

Before the formal start of the experiment, the researcher administered a pretest on Mathematics Interest Inventory (MII) and Mathematics Achievement Test (MAT) to both control and experimental groups. In taking the tests, the student-participants were scheduled by groups (a maximum of 15 students) to adhere with the social distancing protocols inside the classroom. Explanation on the process of taking the MII and MAT to the student-participants were also conducted.

Upon retrieval of the pretest, the distributions of DepEd modules for the control group and the developed PBCMPs embedded with phenomenon-based learning activities for the experimental group followed. As for the process of distribution and retrieval of the self-learning materials, the control group followed the 1 subject – 1 week scheme executed by the school, while the microlesson packets for the experimental group were distributed gradually to each student-participant on a weekly basis. They were given two (2) microlesson packets per week containing lessons intended for one week for the students to study and answer. This means that the lessons assigned were given to students in chunk and not in whole. In the succeeding week, after the student-participants returned their previous microlesson packets, they got the next two (2) microlesson packets for the week until all designed microlesson packets were given to them. The posttest for MII and MAT were administered to the students a week after the last two (2) microlesson packets were retrieved. It was administered face-to-face following covid-19 protocols with the same arrangement as the pretest.

2.5. Data Analysis

The researchers used mean and standard deviation to analyze all data gathered. The analysis of covariance (ANCOVA), with pretest as the covariate, was then used to determine the significant difference between the mathematics achievement and significant difference between mathematics appreciation when exposed to the phenomenon-based conversational microlesson packets and those exposed to non-phenomenon based self-learning material.

3. Results and Discussions

Table 1 shows the pretest and posttest mean scores and standard deviation and descriptive level of students' mathematics achievement on the topic about Sets.

Table 1. Mean and standard deviation of mathematics achievement

Group	Time of Appraisal	Mean	SD	Level of Mastery
Control	Pretest	3.74	1.59	Low Mastery
n=31	Posttest	11.19	2.88	Low Mastery
Experimental	Pretest	4.06	1.61	Low Mastery
n=31	Posttest	15.13	4.80	Nearing Mastery

Legend:

Range of Mean	Level of Mastery
23.00 - 30.00	Mastery
15.00 - 22.99	Nearing Mastery
0.00 - 14.99	Low Mastery.

Based on the adopted K-12 descriptive level of the mean scores, the results in Table 1 indicate that the students' mean scores from both groups were in the low mastery level in the pretest which suggest that the students have a little knowledge about the subject matter. It can be observed also that the pretest mean scores have a difference of 0.32 only where the experimental group is slightly higher than the control group. This means that the two groups of students had comparable mathematics achievement prior to the administration of the treatment.

In the posttest, the experimental group exposed to phenomenon-based conversational microlesson packets learning material shows a mean score (15.13) higher than the mean score (11.19) of the control group exposed to non-phenomenon-based learning material. The results revealed that both groups have increased their posttest mean scores implying that both groups have manifested improvement. However, it is noticeable that the experimental group has improved more in mathematics achievement compared to the control group as the posttest resulted from low mastery before the treatment to nearing mastery level after the treatment was administered. While the control group has given to gain improvement on posttest mean score, the group still fails to move out from low mastery level.

Further, it can be observed that participants under control group have a standard deviation of 1.59 while students under experimental group have 1.61 during pretest. The difference of the standard deviation value indicates that the scores in the control group is nearly similar compared to experimental group. This means that participants in the control group are homogeneous in terms of their mathematics achievement prior to the treatment. Same observation for the difference of the standard deviations of the control group and experimental group in the posttest. Still, the control group shows more homogeneity in terms of their mathematics achievement as it has an SD of 2.88 lower than the 4.80 SD of the experimental group. To verify whether the difference was significant, ANCOVA was further used.

Table 2. One-Way ANCOVA Summary on Mathematics Achievement

Source of Variation	df	Adjusted Sum of Squares	Adjusted Mean Squares	F	p-value
Group	1	193.656	193.656	15.775	0.001*
Error	59	724.273	12.276		
Corrected Total	61	1180.387			

*Significant at 0.05 level.

Table 2 presents the results of the analysis of covariance of pretest and posttest scores for students' mathematics achievement of the experimental and control groups. The analysis yielded a computed p-value lesser than the 0.05 level of significance. This led to the non-acceptance of the null hypothesis. This implies that there is sufficient evidence to conclude that mathematics achievement of the students exposed to phenomenon-based learning material is significantly higher than those exposed to non-phenomenon based.

Table 3 shows the scores of students' mathematics appreciation during pretest and posttest both under the control and experimental groups. As reflected in the Table 3, majority of the participants get the grand mean scores of 4.34 and 4.03 under control and experimental groups respectively. In computing for the grand mean, the responses for items (11-20 and 26) with negative statements were reversed. The grand means suggest that for both groups, the students' initial affective state towards learning mathematics is neutral. With regards to the items related to positive valence, majority of the respondents in the control and experimental groups were uncertain if they are interested, excited and would like to spend more time working and talking about mathematics (items 3, 7, 9, 21, 22, 24 and 25) in the pretest. Also, for the negative experience related to mathematics which includes being cognitively challenged by mathematics and thus opting to avoid it, majority of the student-respondents were neutral. For instance, in items 18 & 20, both groups are not sure if they struggle and have difficulty paying attention when working on mathematics.

Table 3. Mean and standard deviation of mathematics appreciation

STATEMENTS	Control Group n=31				Experimental Group n=31			
	Pretest		Posttest		Pretest		Posttest	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1. I like to answer questions in mathematics.	4.00	1.69	4.00	1.84	3.19	1.85	4.71	1.51
2. I like mathematics.	3.81	1.66	4.03	1.58	3.55	1.96	4.58	1.50
3. I am interested in mathematics.	4.03	1.92	4.26	1.67	3.65	1.82	4.84	1.70
4. Knowing a lot about mathematics is helpful.	5.71	1.55	4.84	1.51	5.23	1.94	5.06	1.71
5. I feel happy when it comes to working on mathematics.	4.68	1.51	4.23	1.20	4.19	1.94	4.87	1.36
6. I want to know all about how to do mathematics problems.	5.23	1.59	4.74	1.93	4.61	1.94	5.23	1.65
7. I am excited when a new mathematics is announced.	4.10	1.42	3.97	1.22	3.87	1.88	4.32	1.66
8. I want to learn more about mathematics.	5.45	1.48	5.10	1.51	5.19	1.94	5.00	1.75
9. I choose to work on mathematics.	4.00	1.81	3.65	1.52	3.68	1.94	4.87	1.28
10. I want to know all about mathematics.	4.77	1.67	4.81	1.66	5.39	1.69	5.13	1.80
11. I am wasting my time on mathematics.	4.45	1.65	4.65	1.54	4.42	1.93	4.58	1.82
12. I am bored when working on mathematics.	5.10	1.47	4.71	1.62	4.13	1.96	4.13	1.82
13. I would rather be working on something else besides mathematics.	4.45	1.545	4.68	1.38	3.84	1.99	4.26	1.65
14. I give up easily when working on mathematics.	4.32	1.56	4.55	1.48	4.68	1.99	4.32	1.51
15. When working on mathematics, I want to stop and start working on something else.	4.58	1.71	4.35	1.52	3.58	1.95	4.19	1.30
16. I am always thinking of other things when working on mathematics.	4.39	1.82	4.26	1.75	3.45	1.93	4.23	1.75
17. I get mad easily when working on mathematics.	4.74	1.81	4.87	1.46	4.03	1.84	4.55	1.93
18. I have difficulty paying attention when working on mathematics.	4.03	1.49	3.94	1.29	3.68	1.99	4.19	1.92
19. I spend as little time as possible working on mathematics.	3.68	1.89	3.61	1.50	3.45	1.75	3.65	1.66
20. I struggle with mathematics.	3.68	1.42	4.29	1.55	3.90	1.58	4.45	1.57
21. I work more mathematics problems than I love to.	3.87	1.63	3.97	1.45	3.58	1.95	4.19	1.74
22. I spend many hours working on mathematics.	3.81	1.66	4.16	1.64	4.19	1.91	4.39	1.56
23. I work on mathematics in my spare time.	4.55	1.73	4.58	1.39	3.65	1.62	3.94	1.65
24. I want to talk about mathematics with my friends.	4.10	1.92	4.32	1.49	3.97	1.92	4.00	1.90
25. I spend more time than my classmates working on mathematics.	3.90	1.74	4.03	1.74	4.06	1.91	3.97	1.82
26. I prefer easy mathematics over mathematics that is hard.	3.97	1.82	3.61	1.76	3.29	1.92	3.97	1.68
27. I am too involved in mathematics.	3.84	1.49	4.48	1.31	4.45	1.90	4.42	1.67
Grand Mean/SD	**4.34**	**0.56**	**4.32**	**0.66**	**4.03**	**0.70**	**4.44**	**0.57**

Legend:

Rating	Range of Mean	Verbal Description	Qualitative Interpretation
7	6.16 - 7.00	*Very True of Me*	*Very High*
6	5.30 – 6.15	*True of Me*	*Moderately High*
5	4.44 – 5.29	*Somewhat True of Me*	*Slightly High*
4	3.58 – 4.43	*Not Sure*	*Neutral*
3	2.72 – 3.57	*Somewhat Not True of Me*	*Slightly Low*
2	1.86 – 2.71	*Not True of Me*	*Moderately Low*
1	1.00 – 1.85	*Not at All True of Me*	*Very Low*

However, it can also be observed that the grand mean scores for both groups are slightly higher than the midpoint of the scale (4.0) which represents the neutral disposition of the respondents towards learning mathematics. This suggests that students are inclined to have a positive disposition with regards to learning mathematics. Further, it can be observed that participants under control group have a standard deviation of 0.56 while students under experimental group have 0.66. The difference of the standard deviation value indicates that the scores in the control group is nearly similar compared to experimental group. This means that participants in the control group are homogeneous in terms of their mathematics appreciation prior to the treatment.

Table 3 further shows the scores of student-participants in terms of mathematics appreciation during posttest both under the control with mean score of 4.32 and students under experimental group with mean score of 4.44. For the control group, the means of the 16 out of 27 items fall between the range 3.58 – 4.43 which implies the neutrality of the students' mathematics appreciation regardless of the positivity or negativity of the statements in the posttest. Also, the slight decrease of the mean in the posttest implies that the mathematics appreciation of the students in control group had reduced after their exposure to non-phenomenon based self-learning material. The result is opposite in the case of the experimental group, since the posttest shows a one-step range of grand mean increase which indicates that student-respondents' mathematics appreciation is no longer neutral but is now slightly high for them. Majority of the student-respondents gained interest in learning mathematics (items 1, 2, 6, 8, 9, & 10), felt happy when it comes to working on mathematics (item 5) and believed that knowing a lot about mathematics is helpful (item 4). This implies that students' mathematics appreciation was develop after their exposure to phenomenon-based conversational microlesson packets. Additionally, it can be observed that participants under control group have a standard deviation of 0.66 while students under experimental group have 0.57. The outcome is different for the posttest as the difference of the standard deviation value indicates that the score in the experimental group is practically more similar compared to the control group. This means that participants in experimental group are more homogeneous in terms of their mathematics appreciation after the treatment was administered. This implies that the effect of the treatments varied depending on how the student-participants engaged in mathematics learning whereby students enjoy or did not enjoy the learning process. This means further that some students managed to increase their mathematics appreciation as high as possible while others failed to increase their appreciation in mathematics in the posttest.

To determine if there is a significant difference on the effects of the treatments both in control and experimental groups, further analysis is done using analysis of covariance (ANCOVA) as shown in Table 4.

As shown in Table 4, the analysis resulted a computed probability value of .010 which is less than 0.05 level of significance. Thus, there is sufficient evidence to reject the null hypothesis. It can be inferred therefore that there is significant difference on students' level of mathematical appreciation of participants under the control and experimental groups. The findings also shown that the result in the experimental group is remarkably higher than control group in favor of the group who had exposed to phenomenon-based learning activities in the PBCMPs. This finding suggests that the integration of phenomenon-based learning in the developed self-learning material for mathematics evidently promotes mathematics appreciation among students.

Table 4. One-way ANCOVA Summary on Mathematics Appreciation

Source of Variation	df	Adjusted Sum of Squares	Adjusted Mean Squares	F	p-value
Group	1	1.530	1.530	7.146	0.010*
Error	59	12.636	0.214		
Corrected Total	61	23.111			

*Significant at 0.05 level.

The results revealed that the other approach did not demonstrate a considerable gain towards mathematics achievement and appreciation while the latter appeared to have higher and consequently tested as remarkably more effective. Instilling students with a strong desire to know or learn something is what every teacher lives for, and research has even shown that stimulating curiosity is one of the processes in triggering interest or appreciation in learning things [12]. It is interesting to note that in this innovation, phenomenon-based learning particularly impresses where students connect learnings to the real-world context with problem solving that may trigger their curiosity and challenge them to solve using their prior and gained knowledge that eventually helps improve their achievement in mathematics [11]. The vital part of the process in phenomenon-based learning is student's active role in creating an understanding of the phenomenon that contributes not just to learning the topic but also in gaining appreciation of the subject matter [17].

4. Conclusion and Recommendation

Based on the findings of the study, phenomenon-based learning positively influenced the students' mathematics achievement and appreciation more effectively if embedded in the activities of a self-learning material. The results of this study may help Mathematics teachers as well as other learning material teacher developers to measure the effectiveness of their developed material with integration of various teaching pedagogy and learning strategies such that students' mathematics achievement and appreciation is developed. In addition, school administrators may initiate wide dissemination such as seminar-workshop on phenomenon-based learning as an approach in the teaching and learning mathematics subjects. Furthermore, similar studies may also be conducted to a broader scope using various population in different learning institutions for refinement of the method. Lastly, they can also use the results of this study as a benchmark on some future research which primarily aims to enhance students' mathematics achievement and appreciation.

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