Enhancing Students' Mathematical Thinking through Math Journal

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Abstract--- *This quasi-experimental study focused on the investigation of the effectiveness of Math journal in the teaching of Mathematics in the Modern World particularly in enhancing Mathematics performance among first year Bachelor of Elementary Education students of Cagayan State University, Andrews Campus, Tuguegarao City for second semester school year 2018-2019. This study ascertained that journal entries in Mathematics are valuable in providing opportunities for students to acquire substantial knowledge and coherent understanding of Mathematics concepts by communicating their learning in their own words. Thus, the integration of Math journal in teaching significantly enhanced communication skills, mathematical thinking and performance of students in Mathematics. The paper also disclosed that journal activities provide the students with opportunities to develop a broader understanding of the various concepts in Mathematics and learn to communicate how they feel about the learning environment. Moreover, Math journal provides an avenue for students to undergo the process of self-reflection and self-assessment. Hence, through the diverse Math journal activities, the learning of Mathematics becomes more meaningful and interesting.*

Keywords--- *Mathematical Thinking, Math Journal, Mathematics in the Modern World.*

I. INTRODUCTION

The ability to think clearly and rationally is the most significant attribute that differentiates man from other creatures. Mathematics is a discipline that develops thinking and Mathematics education provides the skill of thinking in life. Mathematical thinking is an influential way of thinking about things in the world logically and analytically. Mathematical thinking style is an individual thinks, understands and presents mathematical connections by external and internal representations (Ferri, 2015). Mathematical thinking can be learned or developed. Thus, it is one of the primary goals of education for it supports sustainable Mathematics learning.

Mathematical thinking is vital for the academic achievement of students in Mathematics. By enhancing mathematical thinking, learners can recognize numerous strategies to solve a problem and determine the most effective strategy. Several studies emphasized the necessity for interminable enhancement of mathematical thinking in education. Kostos & Shin (2010), pointed out that the communication of mathematical thinking, as well as vocabulary in Mathematics of students, is positively influenced through the use of Math journal. Hence, when implemented effectively, Math journal is one of the ways to improve the mathematical thinking of learners.

Math journal is a notebook where students record their solutions and strategies in solving problems. In accomplishing the journal, students learn how to do Math as well as how to articulate what they have learned. Math journal helps students clarify their thought process while they further develop content knowledge. It also leads to a

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clearer picture of the problem and the identification of varied strategies that can be utilized to solve the problem. Moreover, Math journal develops reflective thinking during the process of problem-solving when students evaluate their problem-solving strategies and identify strengths as well as their weaknesses in their mathematical understanding.

Likewise, Vygotsky regarded the Math journal as a vital instrument in facilitating the brain to make connections from previously learned information with new concepts (Pugalee, 2004). His idea supports the use of journal writing in developing a better understanding of the lessons in Mathematics.

Language is intensely involved in Mathematics learning as learners think and communicate about mathematical concepts. Thus, the power of writing Math journal cannot be underestimated as it plays a significant role in improving learners' progress. Russell (2018), pointed out that mathematical thinking, as well as communication skills in Mathematics, can be further developed and enhanced through journal writing. The Math journal is a valuable tool in providing students opportunities to evaluate their learning, mathematics ability, and ability to express ideas clearly. The journal entries can also be used for reflections on their work and for feedback to improve classroom instruction and student learning. The write-ups on their reasoning processes provide a valuable insight of what they understood, their approaches and misconceptions. The dates on the entries of the journal also provide a record of the development of a student's mathematical thinking throughout the teaching-learning process.

Several researches had investigated the writing of the journal and its use in Mathematics classes. Pugalee (2004), cited that journal writing is an effective tool for supporting metacognitive mathematical problem solving after comparing the consequence of the utilization of written and verbal understanding of problem-solving. Kostos & Shin (2010), investigated the journal as an assessment tool in Mathematics and their findings pointed out that journal writing improved the mathematical thinking, vocabulary, and understanding of students on the concepts of Mathematics.

At Cagayan State University, the instructional focus in Mathematics classes has been primarily on calculation and procedural skills, with less emphasis on developing conceptual understanding. As a result, students could hardly explain their thought processes in solving problems in Mathematics. Therefore, Mathematics teachers need to explore the use of journal writing as a powerful learning aid to promote conceptual understanding in Mathematics.

Although Mathematics educators across the university have recognized that Mathematics is directly linked with language and believed that Math journal is beneficial, not many have tried to implement journal writing in their classrooms. Armed with the above information, the researchers were challenged to investigate the effectiveness of Math journal in enhancing students' mathematical thinking of the first year Bachelor of Elementary Education students of the College of Teacher Education.

Objectives of the Study

This study was purposely conducted to investigate the effectiveness of Math journal on students' mathematical thinking in Mathematics in the Modern World (MMW) among first year Bachelor of Elementary Education (BEEd) students of the College of Teacher Education, Andrews Campus, Tuguegarao City. Specifically, it sought to: (a)

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determine the pretest and posttest mean scores of the groups of subjects in MMW; (b) determine if a significant difference exists in the pretest mean scores of the control and experimental groups; (c) determine if a significant difference exists in the posttest mean scores of the control and experimental groups; and (d) determine if a significant difference exists in the pretest and posttest mean score of the subjects in the experimental groups.

II. METHOD

Research Design

The researchers utilized the quasi-experimental method, specifically, the pre-posttest design involving the control and experimental groups. A pre-test was administered to both groups to ensure that they are comparable before the experimental phase. The Math journal was integrated in teaching the experimental group while the traditional method of teaching was employed in the control group.

Respondents and Sampling Procedure

The two classes of the first year BEEd students enrolled in Mathematics in the Modern World for the second semester of the school year 2018-2019 served as the subjects of the investigation. Each class consisting of 45 students was identified through the pre-test and the subjects in both groups were matched through the ranking method.

Research Instrument

The research instruments used to gather the needed data were the teacher-made test and Math journal. The teacher-made test was a 50-item multiple choice exam that covered the topics on the subjects Mathematics in the Modern World. The test items, taken from the test bank of the researchers, were validated by experts and revised according to the result of a series of item analysis.

Moreover, the math journal activities used in the study were crafted by the researchers following procedural guidelines. The researchers identified appropriate parts of the journal considering suitable format and content. After the researchers had developed the math journal, colleagues teaching the same subject and other technical experts were requested to critique the materials and provide suggestions for further improvement. Following the comments and suggestions given by the evaluators, the researchers made the necessary revisions on the instructional material. Sample math journals were tried out with students who were not subjects of the study to ensure its overall effectiveness.

Data Gathering Procedure

To obtain the data, the researchers requested permission for the conduct of the study from the dean of the college. Upon approval, the researchers administered the 50-item test to both groups of students involved in the study.

The developed Math journal was used by the experimental group during the semester while the traditional method was utilized in teaching the control group. After the exposure to the teaching methods, a similar 50-item test given prior to the conduct of the study was administered to the subjects.

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Data Analysis

Statistical tools like frequency count, mean and percentage were used in the treatment of the pre-test and post-test scores gathered in the study. Moreover, the scores of both groups were described using this arbitrary scale.

Score	Interpretation
41-50	Excellent(E)
31-40	Very Satisfactory (VS)
21-30	Satisfactory (S)
11-20	Poor (P)
0-10	Very Poor (VP)

The t-test for independent and paired samples was used to calculate whether a significant difference exists in the pre-post-tests scores of the subjects.

III. DISCUSSION

The following salient findings were established by the researchers based on the results of the investigation.

1. Mean performance scores in the pre-test and post-test of the control and experimental groups

Table 1: Frequency and Mean Distribution of Subjects' Pre-test and Post-test scores

	Experimental Group (n = 45)				Control Group (n = 45)			
Scores	Pre-test		Post-test		Pre-test		Post-test	
	f	%	F	%	f	%	f	%
41-50 (E)			25	55.56			5	11.11
31-40 (VS)	2	4.44	20	44.44	1	2.22	24	53.33
21-30 (S)	24	53.33			22	48.89	16	35.56
11-20 (P)	19	42.22			22	48.89		
0-10 (VP)								
Mean (interpretation)	21.78 (satisfactory)		41.11 (excellent)		21.51 (satisfactory)		32.78 (very satisfactory)	

As indicated in the table, with respect to the pre-test, majority of the subjects from the experimental and control groups had scores ranging from 11-30 with corresponding percentages of 95.55 and 97.78.

The table further reveals that the experimental and control groups had mean pre-test scores of 21.78 and 21.51, respectively. The mean ratings indicate that both groups had a satisfactory performance before the conduct of the study. This implies that students have not fully mastered the basic skills and have not completely attained the competencies set in their high school Mathematics which are fundamental in the course Mathematics in the Modern World.

On the other hand, based on the post-test scores, the table also shows that majority or 55.56% of the subjects from the experimental group had excellent performance. Whereas, in the control group, majority or 88.89% of the subjects had performance ranging from satisfactory to very satisfactory.

Furthermore, it is reflected in the table that the experimental group and control group obtained a mean score of 41.11 and 32.78 in the post-test with a descriptive value of excellent and very satisfactory respectively. The data reveal that the performance of both groups improved after the experimentation. However, the experimental group manifested higher post-test mean performance compared with the control group. This result evidently manifests that employing the Math journal as an instructional strategy in Mathematics could enhance performance.

2. T-test on the significant difference in the pre-test mean performance scores of the control and experimental groups

Table 2: t-test on the Significant Difference of the Pre-test mean Performance Scores of the Experimental and Control Groups

Test	Group	Mean	SD	df	t-value	p-value	Interpretation
Pre-test	Experimental (n = 45)	21.78	3.77	88	-0.313	0.755	Not Significant
	Control (n = 45)	21.51	4.28				

As shown in the table, the pre-test scores of the two groups yielded a computed t-value of -0.313 and a probability value of 0.755 at .01 level. This means that there is no significant difference between the performances of the two groups before their exposure to the teaching methods. This finding signifies that the subjects are initially comparable in terms of their performance prior to the experimentation.

3. T-test on the significant difference in the post-test mean performance scores of the control and experimental groups

Table 3: t-test on the Significant Difference of the Post-test Mean Performance Scores of the Experimental and Control Groups

Test	Group	Mean	SD	df	t-value	p-value	Interpretation
Post-test	Experimental (n = 45)	41.11	2.13	88	-9.69	0.000	Significant
	Control (n = 45)	32.78	5.35				

The table reveals that the post-test scores of the experimental and control groups recorded a computed t-value of -9.69 and a probability value of 0.000 at 0.01 level. Hence, there is a significant difference between the performances of the two groups after their exposure to the teaching methods. This finding signifies that the use of Math journal supports metacognitive thinking and tends to enhance mathematical understanding and performance of students.

4. T-test on the significant difference in the pre-test and post-test mean performance scores of the experimental group

Table 4: Test of Significant Differences on the Mean Performance Scores of the Experimental Group

Variables	Mean	Mean Difference	df	t-value	p-value	Int.
Pre-test	21.78	19.33	44	-39.43	0.000	Significant
Post-test	41.11					

As revealed in the table, the mean difference of 19.33 indicates a significant increase in the mean performance scores of the subjects that utilized the Math journal. The computed probability value of 0.000 further infers that there is a significant difference in the scores of the subjects before and after the experimentation. Thus, Math journal

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is found to be effective in enhancing students' academic performance. This implies that Math journal provides students with opportunities to explicitly articulate their complex understanding of the different math key concepts and positively influenced their performance in Mathematics.

IV. CONCLUSION

The findings of the study lead to the following conclusions:

The integration of Math journal in learning the concepts of Mathematics in the Modern world significantly enhanced the performance of students. This implies that Mathematics learning can be made more meaningful and effective through journal writing.

The Math journal has features that afford the students with the opportunity to communicate their knowledge about Mathematics and how they feel about the learning environment. Moreover, Math journal provides a clear window into what they understood and how they were making sense of the concepts through reflection and assessment. Hence, through the diverse Math journal activities, the learning of Mathematics becomes more meaningful and interesting.

V. RECOMMENDATIONS

In accordance with the aforementioned findings and conclusions, the researchers recommend the following:

1. Mathematics teachers should continuously engage students in varied Math journal activities to enhance their mathematical thinking as well as communication skills in Mathematics.
2. Mathematics teachers should explore other meaningful teaching-learning strategies and activity-based learner-oriented approaches that will make learning meaningful and improve the performance of students in Mathematics.
3. The CSU administration should sustain its immense support to the utilization of Math journal in the teaching-learning of Mathematics.
4. Parallel studies may be conducted in other areas of Mathematics to include variables that may affect the effectiveness of Math journal.

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