

Do COST Assessment and Reading Comprehension Matter on Mathematics Achievement and Creativity?

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Abstract The study determined the effect of COST model which consist of Concept Mapping, Open-ended questions, Synthesizing and Testing for recall of concepts and processes on the Grade 7 students' Mathematics Achievement and Creativity of Bayabas National High School. It employed a pretest-posttest quasi-experimental group design, using a 20-item multiple choice teacher made test to assess students' achievement with a reliability index of 0.75 and 5-item creativity test with a reliability index of 0.83 to assess students' mathematics creativity. The school has four sections of Grade 7, one section was randomly assigned as the control group using the traditional method of assessment and another randomly chosen section as the experimental group using COST model of assessment. The two-way analysis of covariance (ANCOVA) unequal n's was used to analyze the data collected since participants were classified in terms of their reading comprehension ability and the two models of assessment. Results of the analysis revealed that the participants of the COST model assessment have significant effect in the increase in their Mathematics achievement with respect to Reading Comprehension. In addition, Creativity which was evaluated in terms of mathematical flexibility, fluency and originality scores of the students in the Experimental and Control group with respect to their Reading Comprehension Level are comparable. Hence, the researcher recommends that the teacher may use COST assessment model to enhance students' mathematics achievement and creativity since it has higher score and is comparable to standard assessment.

Keywords: Reading Comprehension, Creativity, Mathematics Achievement

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1. Introduction

Mathematics plays a critical role in the school curriculum as it aims to develop mathematical proficiency, creativity, and critical thinking in students DepEd [1]. But, how can this be achieved, if the students struggled in Mathematics. Most students are consistently struggling with creative thinking skills, as highlighted by the 2024 Programme for International Student Assessment (PISA) results. In the 2022 PISA cycle, fifteen-year-old students in the Philippines scored an average of just 14 points in creative thinking, placing the country among the bottom four of 64 nations [2]. This revelation adds educational challenges faced by the Department of Education (DepEd), as the country once again has the lowest proficiency levels. With a global ranking of 77th out of 81 countries in reading, mathematics, and science.

Despite the extensive research and efforts of educational leaders, many students still find mathematics challenging. The reason might lie in the method of assessment, which need to be studied.

Research supports the importance of diverse assessment methods. Shaw et al [3] highlight that flexible

mathematical thinking is crucial for cognitive development. Siadat [4] emphasizes the role of fluid intelligence in education, which can be enhanced through varied assessments. Romero et al. [5] and Blanche [6] show a positive correlation between fluid intelligence and academic performance, particularly in tasks requiring higher-order thinking skills. O'Neill [7] states that Diversifying assessment led students being more engaged and feeling empowered.

Mutodi et, al [8] advocated the need for better ways to represent learners' conceptual understanding in the form of concept map as an alternative assessment tool. As cited by Rahayuningsih [9], said that open-ended tests are an effective instrument to measure creative thinking. Student with divergent thinking is able to produce new and original solutions to open-ended problems and this link between creative thinking and open-ended problems Dietrich & Kanso, [10]. Another assessment is Synthesizing lessons, this could see bigger picture and students can apply their knowledge to new situations, which is essential for critical thinking and problem-solving. Also, Testing for recall of concepts and processes is an effective assessment technique that measures students' ability to retrieve information from memory. Research shows that recalling tasks can significantly

improve retention and understanding of material, making them a valuable tool in education TeacherToolKit [11].

Combining all these varied assessment leads to the COST model of assessment. The COST model (Concept Mapping, Open-ended questions, Synthesizing, Testing for recall) of assessment is designed to support these goals. This model includes concept mapping to foster creativity, open-ended questions to enhance analytical thinking skills, synthesizing lessons in various forms to enhance comprehension and testing for recall to connect concepts and processes in mathematics. By integrating these diverse assessments methods, this may support DepEd MATATAG initiative which emphasizes reasoning, problem solving and effective communication. A key component of this curriculum is assessment which aligns with pedagogical conceptual approach to achieve high mathematical proficiency and creativity DepEd [12].

Additionally, Guthrie & Klauda [13] emphasize the importance of assessing reading comprehension to support literacy development and critical thinking. Reading comprehension and mathematics achievement are closely connected. Strong reading comprehensions skills can significantly enhance students' ability to understand and solve mathematical problems Akin [14].

The cost model of assessment may have a significant impact on students' academic performance and creativity since this model offers a multifaceted approach of assessment, it does not only solidify foundational knowledge but also encourages critical thinking and innovative problem-solving method. It is in this context that this study is undertaken to determine the effectiveness of the COST model of assessment and reading comprehension on students' mathematics achievement and creativity.

2. Methodology

2.1. Research Design

This study used a quasi-experimental pretest-post-test non comparable control group design with qualitative portion.

2.2. Sampling Procedure

The sampling procedure was purposive since intact classes was used. There were four sections in the grade 7 Level of Bayabas National High School. Two sections were randomly chosen from the four heterogeneous classes and were assigned as control group and experimental group.

2.3. Participants of the Study

There were two sections with 72 Grade-7 student participants of the study. It was conducted at Bayabas National High School, Cagayan de Oro City, during the first quarter of the school year 2024-2025. One section was randomly assigned as the control group who were assessed using the traditional method of assessment and the other as the experimental group who were assessed using the COST model of assessment.

2.4. Research Instrument

There were two teacher-made questionnaires used. The participants answered a 20-item achievement test with a reliability index of 0.75 and 5-item creativity test with a reliability index of 0.83.

2.5. Data Analysis

Data analysis used are mean, standard deviation, and two-way Analysis of Covariance (ANCOVA) unequal n's to determine the effects of treatment and reading comprehension on achievement and creativity scores.

2.6. Data Collection

The data were collected to determine the effect of multiple assessments specifically COST method of assessment on learner's mathematical achievement and creativity when participants are classified in terms of their reading comprehension ability.

In this study, both control and experimental groups received the same instructions based on MATATAG Exemplar and they differ only in the assessment as well as their reading comprehension ability. The control group had daily time-pressured paper and pencil tests with options like multiple-choice test, matching type, fill-in-the blanks and true or-false. The experimental group used COST model incorporating at least two types of tests.

Weekly summative tests were given to both groups: traditional multiple choice for the control group and COST model tests for the experimental group. COST stands for Concept mapping, Open-ended questions, Synthesizing lessons, and Testing for recall, connections of concepts and processes. This model aimed to develop critical thinking skills and creativity.

After the class has completed the topics intended, the researcher administered posttest on both groups, the achievement test and creativity test instruments.

3. Results and Discussion

Table 1 shows the mean and standard deviation of the control group and experimental groups in the mathematics achievement test scores categorized in terms of reading comprehension levels as below average and average.

For the below average category, the control group had a pretest mean of 5.00 out of 20 and a posttest mean of 10.21, while the experimental group started with a pretest mean of 5.89 and achieved posttest mean of 10.30 which only 52% of the total posttest. But, indicates an improvement in scores for both groups, though not remarkable. In the average reading comprehension ability, the control group had a pretest mean of 7.75 and a posttest mean of 15.67, whereas the experimental group had a pretest mean of 6.44 and a posttest of 14.78. Both groups improved, but the control had a higher posttest mean. Overall, the control group's mean score increased from 5.92 to 12.03, and the experimental group's mean score went from 6.03 to 11.42, showing gains for both groups with the control group having slightly higher overall posttest mean.

The standard deviation for both groups increased from pretest to posttest, indicating a broader range of scores post-intervention. Specifically, the control group's standard deviation increased from 1.95 to 3.53, and the experimental groups from 1.75 to 3.10. These findings shows that both interventions led to slight increases in achievement scores and variability.

To determine if there is a significant effect of the treatment and reading comprehension ability on the Mathematics Achievement Scores Two-way Analysis of Covariance ANCOVA unequal n was used.

Table 2 shows the result of a Two-way Analysis of Covariance (ANCOVA) unequal n's to determine the effects of Reading Comprehension and Assessment on students' mathematics achievement.

For factor A which is Reading Comprehension Level, the analysis yielded an F-ratio of 5.28 with a probability value of 0.001 which is less than the 0.05 level of significance. This means that the mathematics achievement of average reading comprehension have a significantly higher mean achievement compared to those participants with low reading comprehension ability. This led the researcher to reject the null hypothesis. This implies that the posttest mean score of the experimental group, which is 15.29 is significantly higher than the control group posttest mean score which is 10.25. This results conforms to the study of Clinton-Lisell et.al. [15] that higher mathematics performance is influenced by high reading comprehension ability. It also supports Espia and Cortezano [16] who revealed that the higher learners' reading comprehension, the better is their academic achievement. These findings highlight the critical role of reading comprehension in academic success as well as in the development of critical thinking and creativity better. Good comprehension enhances further insights.

However, for Factor B which is Assessment models (traditional vs. COST) yielded an F-ratio of 0.09 with a probability value of 0.065 which is greater than 0.05 level of significance. This led to the acceptance of the null hypothesis. It did not show a significant difference in

achievement scores, implying that both methods are comparable. The participants who were assessed using the traditional method of assessment is as good as the participants who were subjected to the COST model. Furthermore, there is no interaction of participants scores as influenced by reading comprehension and assessment models as evidenced by the probability value of 0.065 indicating that there is no mixed effects on achievement scores. The increase ratio of the participants' score in the posttest is proportionate to their pretest score ratio.

Table 3 shows the mean and standard deviation of students' creativity scores in solving problems, categorized in terms of their reading comprehension levels (Below Average and Average) and assessment model for the control and experimental groups. For the Below Average category, the control group had a pre-test mean of 8.38 and a post-test mean of 17.67 out of 75, while the experimental group had a pre-test mean of 9.51 and a post-test mean of 24.04, indicating an improvement in creativity scores for both groups but those participants in COST model is higher than those in the traditional method. In the average category, the control group had a pretest mean of 18.67 and a posttest mean of 26.42, whereas the experimental group had a pretest mean of 17.56 and a posttest mean of 34.56, still those in the COST model is higher than the traditional method of assessment. Overall, the control group's mean score increased from 11.81 to 20.58, and the experimental group's mean score went from 11.53 to 26.67, with the experimental group showing slightly higher overall posttest mean. The standard deviation for both groups increased from pretest to posttest, showing a wider variability of scores after the participants who underwent different method of assessment. Specifically, the control group's standard deviation increased from 6.53 to 7.93, and the experimental groups from 5.90 to 7.76. These data shows that both interventions led to higher variability in creativity scores, with the experimental group showing less variance of scores after the treatment.

Table 1. Mean and Standard Deviation of Students' Mathematics Achievement Test Scores in terms of Reading Comprehension and Assessment Method

Reading Comprehension Level		Control Group (Traditional Assessment)		Experimental Group (COST Assessment)		TOTAL	
		Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
Below Average	$\bar{x}$	5.00	10.21	5.89	10.30	5.47	10.25
	SD	1.38	2.34	1.78	2.52	1.65	2.42
	n		24		27		51
Average	$\bar{x}$	7.75	15.67	6.44	14.78	7.19	15.29
	SD	1.60	2.57	1.67	2.11	1.72	2.37
	n		12		9		21
TOTAL	$\bar{x}$	5.92	12.03	6.03	11.42	5.97	11.72
	SD	1.95	3.53	1.75	3.10	1.8	3.32
	n		36		36		72

Table 2. Summary Table of Two-way Analysis of Covariance unequal n's of Mathematics Achievement Scores

Sources of Variation	SS*	df	Ms*	F-ratio Computed	Probability value
Factor A (Reading Comprehension Level)	26.73	1	26.73	5.28	0.001
Factor B (Assessment Models)	0.47	1	0.47	0.09	0.065
Interaction	0.22	1	0.22	0.04	0.068
Error Within	339	67	5.06		

Significance at 0.05 level

Table 3. Mean and Standard Deviation of Students Creativity Scores

Reading Compre hension Level	Assessment Models				TOTAL	
	Control Group (Traditional Assessment)		Experimental Group (COST Assessment)			
Below Average						
$\bar{x}$	8.38	17.67	9.51	24.04	8.98	21.06
SD	4.29	5.79	3.81	6.14	4.04	6.63
n		24		27		51
Average						
$\bar{x}$	18.67	26.42	17.56	34.56	18.19	29.90
SD	4.50	8.63	7.11	6.91	5.63	8.78
n		12		9		21
TOTAL	36	36	72			
$\bar{x}$	11.81	20.58	11.53	26.67	11.67	23.71
SD	6.53	7.93	5.90	7.76	6.18	8.47
n		36		36		72

Table 4. Summary Table of Two-way Analysis of Covariance unequal n's on Participants Creativity

Sources of Variation	SS*	df	Ms*	F-ratio Computed	Probability value
Factor A (Reading Comprehension Level)	103.2	1	103.2	2.80	0.051
Factor B (Assessment Models)	46.65	1	46.65	1.27	0.060
Interaction	13.9	1	13.9	0.38	0.120
Error Within	2468.34	67	36.84		

Significance at 0.05 level

Table 4 presents the results of a Two-way ANCOVA on students' creativity scores which includes flexibility, fluency, originality in solving problems, considering the effects of assessment models and reading comprehension levels (below average and average). For reading comprehension levels, the ANCOVA yielded an F-ratio of 2.80 with a probability value of 0.051, which is greater than the critical value at the 0.05 level of significance. This led to the acceptance of the null hypothesis. This means that there is no significant difference in creativity scores based on reading comprehension levels. This implies that the below average scores in creativity is comparable to creativity score of the average after the treatment. This imply further that although the average comprehension ability have higher creativity total mean score yet it failed to reach significance level. Furthermore, this imply also that the below average have improvements in their creativity scores similar to the average group after the treatment.

For the assessment models, the F-ratio was 1.27 with a probability value of 0.06, also greater than the critical value, indicating no significant difference in creativity scores between the traditional method and the COST model assessment. This implies that both assessment methods are equally effective. The COST model is as good as the traditional method of assessment. Even though the mean score of the COST Model is higher, it failed to reach significance level. However, it had shown a higher mean score, indicating a tendency that, if the study were conducted over a longer period, it might become significant. Furthermore, there was no significant

interaction between the score in creativity in terms of reading comprehension levels and assessment models, as evidenced by an F-ratio of 0.38 with a probability value of 0.12. This imply that there is no mixed effect of COST model and reading comprehension on the creativity scores of both participants. These findings align with Ticar's [17] study on the effect of argumentative method of teaching on creativity scores of participants, which found to be comparable mathematical creativity scores between experimental and control groups using problem-solving.

4. Conclusion and Recommendation

Based on the analysis and findings, the researcher concluded that Reading Comprehension can enhance mathematics achievement, and COST model of assessment is as good as the traditional assessment in developing students' mathematics achievement and creativity. Hence, the researcher recommends that the teacher may use COST models of assessment to help students improve reading comprehension and students' mathematics achievement and creativity. Since the participants of the COST model have higher score. Further study on COST be done in all Filipino mathematics class for better generalization.

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