The Effect of 3C's on Students' Interest and Problem Solving Skills in Mathematics

Edmund Emetrio A. Gumaling[1], Charita A. Luna[2], Rosie G. Tan[3]

University of Science and Technology of Southern Philippines, Lapasan Highway, Cagayan de Oro city, Philippines

Abstract: ***The study determined the effect of 3C's (Contextualization, Communication, and Connection) on the Grade-11 students' interest and problem solving skills in General Mathematics of Sankanan National High School. It employed a pretest-posttest-quasi-experimental control group design, using a 20-item teacher-made problem solving questions to assess student's achievement with a reliability index of 0.72 and Mathematics interest inventory with a reliability index of 0.86 to assess the students' Mathematics interest. The school has three sections of Grade-11, so one section was assigned randomly as the control group taught using 7E instructional model and another section as the experimental group taught using 3C's. The one-way analysis of covariance (ANCOVA) was used to analyze the data collected. Results of the analysis revealed that the participants of the 3C's method have significant effect in the increase of their Mathematics interest and achievement compared to those participants in the 7E's. Hence, the researchers concluded that the use of 3C's as a teaching method is effective in enhancing students' Mathematics interest and problem solving skills and is recommended to be used in the Department of Education for students' better achievement, communication, and thinking skills for global competitiveness.***

Keywords: Contextualization, Communication, Connection, Problem solving skill, Mathematics interest

1. Introduction

Mathematics holds a relevant and unique place in the school curriculum as it is important for the development of critical thinking skills of an individual. But, it is sad to note that most of the students are considering mathematics as difficult (Gafoor et al, 2015). The reason might be in the method of teaching which needs to be studied. Contextualization was grounded in a concept that related the transfer of students' skill and motivation; to practice what is in the environment which has the potential to increase achievement (Perin, 2011). It is one of the keys of engaging the students in the teaching learning process that made them relate to actual environment of learners (Reyes, et al. 2019).

Despite the efforts of the educational leaders to make a better result of students' academic achievement, the Philippines still ranked second from the lowest among the 77 participating countries in international assessment of PISA (Program for International Student Assessment 2018). However, this can still be remedied. Mathematics educators as agents of change can possibly remove students' weaknesses by doing innovations that will make students responsible for their learning. Teachers play a key role in improving students' Mathematics performance. Hence, innovation might be appropriate, especially if the process is participative to increase students' performance for both local and international assessments. However, it is argued that contextualization is not a panacea (Beswick, 2011). As pointed out by many researchers, contextual problems do not directly make mathematics easier and motivating for students (Boaler, 1993; Carraher & Schliemann, 2002). The practices of contextualization aim to promote success but the learning process is crucial since teachers have the freedom to organize and develop instructional materials and implement it as curriculum makers (Australian Educational Research, 2018). Therefore, there is a need to have additional innovations on top of the usual contextualization of teaching. Contextualization alone is not enough. There may be a gap in the process of contextualization in teaching. On the other hand, communication is another important medium for students' learning. If students can communicate what they understand, the concepts they learn now can benefit them in the future. According to the National Council of Teachers of Mathematics (NCTM, 2000), "Changes in the workplace increasingly demand teamwork, collaboration, and communication". In addition, there is a need for connections of Mathematics topics and concepts within and across grade levels, between Mathematics and other subjects, and between Mathematics and everyday life, this can contribute to make Mathematics understandable, enjoyable, and meaningful (Annenberg Foundation, 2017).

Another motivating factor for students to easily learn abstract concept is interest. When one is interested in doing the application of the concept, it increases their desire to learn. Interest is an affective domain that is necessary in the learning process. When interest is the ingredient in the process of getting knowledge this will result to high performance. Interest towards Mathematics learning could be considered as a predictor for Mathematics achievement (Heinze et al., 2005). Sauer (2012) found that students' interest towards learning is one of the contributing factors in successful academic performance.

In previous studies, mathematical communication and connection were used as the dependent variables, however in this study, they were used as independent variables as mandated by NCTM process standards to explore their effects on student's mathematical understanding. In view of the above thought, the researcher coined the methodology where almost every necessary steps and factors in teaching are incorporated. Lessons need to be connected to every life situations, which apply Mathematics learning. Thus, this study aims to determine the effect of 3C: Contextualization, Communication, and Connection teaching process on Grade – 11 students' interest and problem solving skills. This process may hasten and raise the students' performance in the national and international assessment in Mathematics.

2. Methodology

Research Design

This study utilized a pretest-posttest quasi-experimental control group design. The data were collected to determine the effect of 3C's on learners' mathematical interest and problem solving skills. The students answered a teacher-made assessment instrument with a reliability index of 0.72 and Mathematics inventory assessment with a reliability index of 0.86.

Sampling Procedure

The sampling was purposive since intact class was used. There are only three sections in the grade-11 curriculum of Sankanan National High School. Using a fish bowl method, the name of the sections was written on a piece of paper and then randomly picked, the first pick was the control group and the second pick was for the experimental groups.

Pa**rticipants of the study**

There were two sections with 74 student participants of the study, taken randomly from the three sections. The two sections randomly assigned as the control and the experimental group.

Research Procedure

In the collection of data, the experimental group of students were taught using the 3C's teaching method. The lesson begun with a contextualized story problem as a springboard of the lesson. The story problem contained contextualized questions. The questions led to the content of the topic. In their group, the students answered the problems and discussed among themselves. This was the start of the communication phase of the 3C'. After their group discussion, they were required to present their answer in front of the class. This facilitated communication from their respective group to the whole class. After the group reporting, the teacher corrected misconceptions of the students. Then the teacher facilitated the class discussion, ensuring student-student and teacher-students discourse. After the discussion of the teacher, the connection phase commenced by asking the students if they can connect their lesson to other Mathematics concepts they have had in their previous grade level. After the connection, the students were given problem solving tasks as a form of evaluation. The cycle is shown in figure 1.

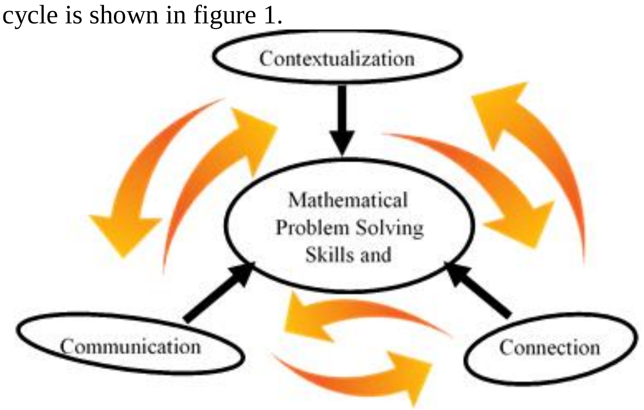

Figure 1: 3C's Teaching Cycle Model

In the control group, the students were taught using the 7E teaching method. The 7E are the following processes: Elicit, Engage, Explore, Explain, Elaborate, Extend, and Evaluate. These processes were facilitated by the teacher in a teacher-student discourse.

The students from both groups were given Mathematics interest inventory after the posttest. The Analysis of Covariance (ANCOVA) was used to analyze the data of both Mathematics interest and achievement in the problem solving. The ANCOVA was used because both of the classes are intact groups. In testing the hypothesis, alpha was set at 0.05 level of significance.

3. Results and Discussion

Table 1: Mean and Standard deviation of the levels of student's interest

Group	Control Group 7E		Experimental Group 3C's	
	Pretest	Posttest	Pretest	Posttest
Mean	2.48	2.52	2.67	3.27
Standard deviation	1.98	0.20	0.32	0.28
Level of Math Interest	Disagree	Agree	Agree	Strongly agree

Legend: 1.75-1.00: Strongly disagree, 1.76 – 2.50: Disagree, 2.51-3.25: Agree, 3.26-4.00: Strongly Agree

Table 1 shows the mean of the pretest and posttest of the control and experimental groups in Mathematics interest in terms of their level. It can be observed that in the pretest, the control group has a disagree level with a mean of 2.48. However, the result of the posttest has shown an increase in their Mathematics interest from disagree to agree with a mean of 2.52. While the experimental group, in the pretest, it has an agree level in Mathematics interest with a mean of 2.67 and reached a strongly agree in the posttest with a mean of 3.27. It seems that the 3C's has motivated their interest in Mathematics.

Meanwhile, the standard deviation of both groups have decreased. The control group decreased from 1.98 to 0.20 while the experimental group decreased from 0.32 to 0.28. The decrease of the standard deviation signified that the individual score of the participants became closer to each other after their classes. They became homogenous and individual scores were clustering towards the mean and have consistency of the response to the given questions.

It can be noted also that the control and experimental group have changed their perspective in terms of agreeing on their interest in Mathematics. Both the 7E and 3C's teaching methods have somehow awakened their interest about Mathematics as evidenced by the increased mean of the Likert scale survey questionnaire. This may be due to their better understanding of the concepts.

Table 2: One-way ANCOVA summary for the students' level of Math interest

Sources	Type III sum of Square	Df	Mean Square	F	Sig
Pretest	0.024	1	0.204	5.641	0.20
Group	8.384	1	8.384	23.626	0.001
Error (Within)	2.570	71	0.036		
Total	633.40	74			

*Significant α = 0.05

Table 2 shows a summary of the analysis of covariance of the level of Mathematics interest. The analysis yielded an F-ratio of 23.626 with a probability value of 0.001 which is less than the critical value 0.05 level of significance. This led to the rejection of the null hypothesis that there is no significant difference in the respondents' level of Mathematics interest as influenced by the use of 3C's and 7E teaching methods. This means that 3C's has significantly increased the Mathematics interest of the participants.

This implies that when 3C's was used in the classroom discussion, students develop Mathematics interest. This result confirmed and supported the Contextualization study of (Nentwig, et al., 2005). However, interest or enjoyment in a course does not necessarily correlate with student learning or achievement, although interest might influence motivation through intrinsic measures or by increasing self-efficacy (Glynn & Koballa, 2006). Communication is an essential part of mathematics education, a way of sharing ideas and clarifying understanding. Through communication, ideas become objects of reflection, refinement, discussion, and connections. The communication process also helps build meaning and permanence for ideas, which is beyond extinction (NCTM, 2000). Through communication, student are provided relevant, meaningful content, and allowing students the opportunity to reflect on their learning and enables them to build connections at various levels and integrate their learning in a larger context and interest.

Table 3: Mean and Standard deviation of the level of problem solving skills

Group	Control Group 7E		Experimental Group 3C's	
	Pretest	Posttest	Pretest	Posttest
Mean	1.30	30.16	1.62	38.80
Standard deviation	1.02	12.57	0.83	10.90
Level of Problem solving skills	Not proficient	Nearly Proficient	Not proficient	Proficient

*** 0-12: Not proficient, 13-24: Low proficient, 25-36: Nearly proficient, 37-48: Proficient, 49-60: Highly proficient

Table 3 shows the mean of the pretest and posttest of the control and experimental groups in problem solving skills in terms of their proficiency level. It can be seen that in the pretest, the control group was not proficient with a mean of 1.30. However, the result of the posttest has shown an increase in their performance by becoming nearly proficient with a mean of 30.16. While the pretest of the experimental group is not proficient also in their problem solving skill with a mean of 1.62. However, in their posttest, the experimental group became proficient with a mean of 38.30. This result is still low because the highest possible score is 60. The mean is only 63.83% far below the 75% mastery level required by the Department of Education.

The standard deviation of both groups have increased. The control group increased from 1.02 to 12.57 while the experimental group increased from 0.83 to 10.90. The increase of the standard deviation showed that the individual score of the participants became widely dispersed in their posttest. This meant that there was a diverse effect of the method on students' performance in problem solving tasks.

Furthermore, the not proficient level result of problem solving skills of the pretest of both groups indicated the students lack of skills or competency because they are not yet exposed to the content in the course of study. This means that the students before the start of the study were not equally knowledgeable or had no mathematical ability in problem solving in General Mathematics. While the posttest result of the control group, which has a nearly proficient level, means that the students has already possessed the basic skills of the course. To determine which method have caused a better effect of the participants' achievement, further analysis was done.

Table 4: One-way ANCOVA Summary for the Problem Solving Achievement

Sources	Type III sum of Square	Df	Mean Square	F	Sig
Pretest	150.82	1	7436.46	208.997	0.001
Group	837.75	1	378.886	10.648	0.016
Error (Within)	9814.758	71	35.582		
Total	99491.00	74			

*Significant $\alpha = 0.05$

Table 4 shows a summary of the analysis of the covariance of the participants' pretest and posttest achievement scores in problem solving tasks. The analysis yielded an F-ratio of 6.146 with a probability value of 0.016 which is less than the 0.05 level of significance. This means that the two teaching methods are not comparable. This led the researcher to reject the null hypothesis. This implies that the mean of the posttest score of the experimental group, which is 38.34, is significantly higher than the control group where the mean score is 30.16.

Furthermore, the result revealed that the use of 3C's as a teaching strategy enhanced the students' ability to analyze and to understand the lesson better. Because the use of 3C's has allowed them to discuss and communicate with each other their ideas as they answered contextualized problem about the topic of the lesson.

In addition, the 3C's posed a positive effect on the students' performance because it gave the students avenue to express ideas, draw inferences, and contribute their own opinions during the discussion whereby they were able to communicate in the group their thoughts, explain, draw conclusion from the shared ideas in a student to student discourse. The students' participation during the reporting stage, allowed them to exhibit their reasoning ability; develop their confidence and ability to illustrate mathematical ideas. This result confirmed the study of (Krause, et al 2016) that contextualization of the course content and concepts can improve student motivation for learning, and persistence. This study also supported the result that communication process build meaning and permanence of ideas to enhance academic performance (Sammons, 2018).

4. Conclusion and Recommendation

Based on the findings of the study, the researchers conclude that 3C's as a teaching method is effective in enhancing student's interest and problem solving skills in Mathematics. Therefore, the researchers recommend the use of 3C's in the teaching-learning process in the public schools. Similar study may be conducted on other discipline to verify the result of the study and for further generalization.

References

[1] Beswick, K. (2011). Teachers' beliefs about school mathematics and mathematicians' mathematics and their relationship to practice. *Educational Studies in Mathematics*, *79*(1),147. https://doi.org/10.1007/s10649-011-9333-2

[2] Boaler, J. (1993). Encouraging the transfer of ? school? mathematics to the ?real world? through the integration of process and content, context and culture. *Educational Studies in Mathematics*, *25*(4), 341 373. https://doi.org/10.1007/bf01273906

[3] DeGeorge, B. Santoro (Dec 2004) Manipuoatives: A hands-on approach to Math *Principal*, *https://eric.ed.gov/?* id=EJ693871

[4] Gafoor, K. A., & Kurukkan, A. (2015). Learner and Teacher Perception on Difficulties in Learning and Teaching Mathematics: Some Implications. *Learner and Teacher Perception on Difficulties in Learning and Teaching Mathematics*

[5] George, T. (2022, May 4). *Semi-Structured Interview Definition, Guide & Examples*. Scribbr. https://www.scribbr.com/methodology/semi structured-intervie

[6] Glynn, S. M. & Koballa, T. R., Jr. (2006). Motivation to learn college science. In J.J. Mintzes & W.H. Leonard (Eds), Handbook of college science teaching (pp. 25-32). Arlington, V.A: National Sciences Teachers Association Press.

[7] Goak L. (2012). Fluency: Fast and Accurate? I Think Not! – National Council of Teachers of Mathematics, NCTM President

[8] Go Silk, C. et al (2017) *Contextualized Problem Solving: Its effect on Students' Achievement, Conceptual Understanding and Mathematics Anxiety* https://www.ijsr.net/archive/v6i7/ART20175656.pdf

[9] Heinze, A., Reiss, K., & Franziska, R. (2005). Mathematics achievement and interest in mathematics from a differential perspective. *Zentralblatt Für Didaktik Der Mathematik*, *37*(3), 212–220. https://doi.org/10.1007/s11858-005-0011-7

[10] Jones, T(March 2021) *The Top 5 Reasons for Using manipulatives in the Classroom.*TLJ consulting Group, LLC. https://tljconsultinggroup.com/the-top-5-rreasons-for-using-manipulatives-in-the-classrom

[11] Krause, U. M., Stark, R., & Mandl, H. (2009). The effects of cooperative learning and feedback on e-learning in statistics. *Learning and Instruction*, *19*(2), 158–170. https://doi.org/10.1016/j.learninstruc.2008.03.003

[12] Kurt, S. (2021, February 21). *Constructivist LearningTheory*. Educational Technology. https://educationaltechnology.net/constructivist learning-theory/

[13] McClure. L. (2019) Developing Number Fluency-What, Why and How https://nrich.maths.org/10624

[14] Nentwig, P., & Waddington, D. (2005). Making it relevant : context based learning of science. *Waxmann EBooks*. http://ci.nii.ac.jp/ncid/BA86776715

[15] Perin, D. (2011). *Facilitating Student Learning Through Contextualization.* *Community College Review*, *39*(3),268295. https://doi.org/10.1177/009155 2111416227

[16] *Quillen.* (2013, January 31). *In Teaching Math, What's the Right Mix of Content and Context?* KQED.

[17] Reimagined, E. (2019, January 30). *How to Shift from Education as Content to Education as Context*. Education Reimagined. https://education reimagined.org/how-to-shift-from-education-ascontent-to-education

[18] Reyes, et al (2010). *Conception and Application of Contextualization in Mathematics*

[19] Saunders, M. L. P. T. A. N. K. (2022). *Research Methods For Business Students*. PEARSON.

[20] Sauer, K. (2012). The Impact of Student Interest and Instructor Effectiveness on Student Performance. *The Impact of Student Interest and Instructor Effectiveness on Student Performance*.

[21] Sammons, L. (2018). Teaching Students to Communicate Mathematically. *Teaching Students to Communicate Mathematically*.

[22] Selvianiresa1, D., & Prabawanto2, S. (2017, September 1). *IOPscience*. Journal of Physics: Conference Series. Retrieved May 23, 2022, fromhttps://iopscience.iop.org/article/10.1088/1742 6596/895/1/012171

[23] Sheppard, V.(2020, April 6). 11.1 Conducting Quantitative Interviews-Research Methods for the Social Sciences: An Introduction. Pressbooks. https://pressbooks.bccampus.ca/jibcreresearchmethods/chapter/11-1-conducting quantitative interviews/

[24] Schliemann, A. D., & Carraher, D. W. (2002). The Evolution of Mathematical Reasoning: Everyday versus Idealized Understandings. *Developmental Review*, *22*(2), 242–266. https://doi.org/10.1006/drev.2002.0547

[25] Schoeffel, S. (2021, May 4). *Teaching resources:Using manipulatives in mathematicslearning*.TeacherMagazine