COMPARING LEARNER GENERATED EXAMPLES AND PROBLEM POSING IN ENHANCING STUDENTS' CONCEPTUAL UNDERSTANDING IN MATHEMATICS

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ABSTRACT: This study compared the effectiveness of using learner generated examples and problem posing methods of teaching on enhancing the students' conceptual understanding. The study employed quantitative quasi-experimental pretest – posttest non-equivalent control group research design. One of the three intact classes of Grade 7 students at Mindanao State University Wao Community High School during the third and fourth quarter of School Year 2016-2017 was randomly assigned as the control group and the other two intact classes as experimental groups. Prior to the experiment, the students' conceptual understanding level were pretested. The control group was taught using the teacher-centered conventional method of teaching while the experimental group under learner generated examples was exposed to generating their own examples and the experimental group under problem posing was exposed to the in between problem posing. After the end of the fourth quarter lessons, posttest was administered to all groups. The data collected were analyzed using one-way ANCOVA. Results of the analysis revealed that the group exposed to learner generated examples and problem posing have better performance in conceptual understanding tests compared to those exposed to conventional method of teaching.

Keywords: Conceptual Understanding, Learner Generated Examples, Problem Posing

1. INTRODUCTION

It is a typical observation during math exams and exercises that students tend to leave and neglect the problem solving part of the test and focus on the items they think are easier. Most often, it is the teacher who end up solving challenging problems and exercises. The students were seen to have no interest and lack the drive to engage into more challenging exercises. This is because they find it difficult to recall the concepts and make necesary connections to relate it to the given problem. According to Menon and Keazer [1] this is because many students prefer to blindly follow instruction rather than reason, that many students were accustomed to do mathematics by following procedures without understanding the conceptual foundation.

The Common Core State Standards Initiative [2] emphasized the importance of conceptual understanding. It suggested that mathematics educators at all levels should seek to develop in their students into varieties of expertise such as adaptive reasoning, strategic competence, conceptual understanding, procedural fluency, and productive disposition. In the Philippines, the Department of Education (DepEd) issued new standards in basic mathematics learning through the K to 12 Enhanced Basic Education Curriculum which emphasized the importance of understanding and appreciation of the key concepts and principles of mathematics (K to 12 Curriculum Guide, [3]. With this, DepEd pushed to adopt the learner-centered pedagogy. Several learner-centered pedagogy were already practiced, one of which is the Learner Generated Examples (LGE). LGE arises from the perspective that mathematics is a constructive activity and is mostly learned when learners are actively constructing objects, relations questions and problems and meanings. It is an important and effective pedagogical strategy whose potential is rarely exploited yet which promotes active engagement in mathematics. It has range of practices in which teachers give responsibility to learners for producing examples that generally illustrate, model and demonstrate mathematical ideas [4].

Another learner-centered pedagogy is the Problem Posing (PP). Problem posing refers to both generation of new problem and reformulation of given problems. Thus, posing can occur before, during or after the solution of the problem [5]. Problem posing is a cognitive activity that has started gaining attention worldwide for cultivating students' thinking in mathematics teaching and learning. Besides aiming to improve students' conceptual knowledge of a mathematics topic, problem posing activities also have potential to enhance higher order thinking skills and creativity among students (Suib,Rosli and Capraro [6].

In an attempt to provide activities that engage and challenge the learners, this study delved into two different known effective methods of instructions namely the Learner Generated Examples and the Problem Posing method of teaching. The study compared the effectiveness of Learner Generated Examples and Problem Posing method of teaching on students' conceptual understanding.

2. THEORETICAL FRAMEWORK

This study on the Learner Generated Examples and Problem Posing was anchored on Bruner's [7] Discovery Learning which proposed that learners' construct their own knowledge and do this by organizing and categorizing information using a coding system. He believed that the most effective way to develop a coding system is to discover it rather than being told by the teacher. So, when students were asked to generate own examples or posed own problems, they have constructed their own knowledge themselves.

Another theory this study was based on, was Kolb's [8] experiential learning theory, which states that learning involves the acquisition of abstract concepts that can be applied flexibly in a range of situations. He further stressed that the impetus for the development of new concepts is provided by new experiences. LGE and PP acknowledge the importance of experience in the process of learning.

This study was also founded on Dewey's (1960)[9] notion that the child learns best through direct personal experience. Participation in meaningful projects, learning by doing, encouraging problems and solving them not only facilitates the acquisition and retention of knowledge but fosters the right character traits. In which also have a direct bearing on LGE where the learner themselves are exemplifying and PP where the learner is being taught how to pose problems themselves.

Vygotsky [10] believed that when a student is in the Zone of Proximal Development *(ZPD)* for a particular task, providing the appropriate assistance will give the student enough of a "boost" to achieve the task. He viewed interaction with peers as an effective way of developing skills and strategies. He suggested that teachers use cooperative learning exercises where less competent children develop with help from more skilful peers - within the zone of proximal development. In this study the group work activities was done in such a way that the less competent students were encouraged to learn together with their skilful group members.

Based on the theories discussed this study was focused on comparing the effect of Learner Generated Examples, Problem Posing and conventional method of teaching on students conceptual understanding.

3. LITERATURE REVIEW

Students' conceptual understanding has been an issue in mathematics learning. Students' low performance was always been attributed to this poor conceptual understanding. The National Council of Teachers in Mathematics (NCTM 2000)[11] specifically identified conceptual understanding as one of the six principles for school mathematics. It emphasized that students must learn mathematics with understanding by actively building new knowledge from experience and previous knowledge.

One hallmark of mathematical understanding is the ability to justify, in a way appropriate to the students mathematical maturity (CCSSI 2016). Conceptual understanding means that students can clearly interpret, explain and apply the ideas that are important and they understand the value of those ideas. Students demonstrate conceptual understanding if they are able to identify and apply ideas to solve problems especially non-routine problems and are able to explain their solutions [12;13,.14] also believed that if a student solves a problem and is able to answers a question why he does such process, he has conceptually understood the topic. According to Soyke [15] that the benefits of having better conceptual understanding in mathematics is that students become competent in their computational skills and develop their ability to solve problem with increasing complexity. Furthermore, Almeda et al [16] and Watson, Jones and Pratt [17] argued that confusions and misconceptions arise from the lack of conceptual understanding and ignoring the concepts behind the situation.

On one hand, Zaskis and Leikin [18] and Watson and Shipman [19] revealed that the learner generated examples method can be used by the students to learn new concepts. They believed that exemplification, developing the individuals' example space, the experience and the learners' own action can develop a generalization of the concepts. They discovered that even low achieving students can benefit from this method. Watson and Mason (2001)[20] also proposed that students would be more likely to remember and to appreciate the importance of conditions, if they were stimulated to construct examples for themselves which show why each of the conditions is necessary. Furthermore, constructing their own examples is likely to prompt them to explore the space of possibilities admitted by definitions, and hence to appreciate both the range of situations encompassed by the definition, and the force of both definition and theorem.

For Brown and Walter [21,22] problem posing was deeply embedded in the activity of problem solving through reconstructing the task by posing new problem(s) in the process of solving and begin to generate and try to analyze a completely new set of problems. Cunningham [23] and Lavy and Shriki [24] revealed that involvement in problem posing has potential to develop the mathematical knowledge of the students and consolidate basic concepts. Tan [25] claimed that problem posing method of teaching can better develop the students conceptual understanding compared to the method strategies and activities suggested by the k-12 curriculum although procedural knowledge was unaffected. Pinter [26] and Khan [27] found in their study that problem posing skill of the students can be developed. The students' skills can even go as far as critiquing given problems and can become more precise and concise in formulating new problems.

4. METHODOLOGY

From among the three sections of grade 7 students in Mindanao State University Wao Community High School, School year 2016- 2017 that the researcher handled, three sections were utilized as the participants of the study. One intact class was randomly assigned as experimental group using Learner Generated Examples method of teaching, another intact class was also randomly assigned as experimental group using Problem Posing Method and the remaining intact class as the control group that was taught using the Conventional method. The study used the 20-item two- tiered teacher-made test with reliability coefficient index of 0.72. The first tier of the test measured the achievement level while the second tier measured the students' conceptual understanding in mathematics of the participants including how they cited connections and gave explanations on their comprehension of the problem.

Quasi-experimental pre-test post test non-equivalent control group research design was employed. The pretest and posttest scores were the primary data used to examine the students' conceptual understanding. The extent of the significant difference on the performance of the three groups was tested using one way analysis of covariance (ANCOVA).

The students' conceptual understanding in mathematics of the first experimental group were developed using learner generated examples. The example generation tasks were given to the students that were divided into groups of five. The groups were given ten to fifteen minutes to generate examples. The students were given prompts that led them to generate the expected concept or principle, then the groups were asked to discuss in front of the class how they managed to complete the tasks and arrive at a generalization. They were then allowed to return to their original seats to continue generating more examples. The teacher-researcher facilitated the activity that were found difficult to accomplish, giving prompts that helped the students recall their previous knowledge and connect it with the current activity.

To develop the conceptual understanding of the experimental group under problem posing method, the problem posing using the What If Not (WIN) strategy adapted from the work of Brown and Walter (2005) was used. The lesson was first presented and an example exercise was given after which the students were divided into groups of five to pose new problem from the one showed to them. The researcher assisted the groups who encountered difficulty by giving prompts that led to posing new problem and solve afterwards. The group was given ten to fifteen minutes to pose another problem based from the original problem. One of the members of each group were then ask to discuss the posed problem and their generalization. They were then instructed to go back to their original seats to individually pose more problems and solve.

In the control group, concepts and principles were developed in conventional manner. Lecture, discussion, board work and seatwork were given. Activities, exercises and method suggested in the DepEd teacher's guide were used. Group activities were sometimes part of this method as suggested by the teacher's guide. The same assessment quiz was given to all three groups at the end of every lesson to monitor the development of the students' achievement and conceptual understanding.

5. RESULTS AND FINDINGS

Table 1. Mean and Standard Deviation of Students' Conceptual Understanding

	Control group n=29		Experimental Group LGE n=29		Experimental Group PP n=29	
	Pre-test	Posttest	Pre-test	Posttest	Pre-test	Posttest
Mean	3.69	10.52	3.83	21.24	4.76	21.10
SD	2.82	6.32	3.10	12.63	3.09	9.94

Table 1 shows the mean and standard deviation of the level of conceptual undsstanding of the students exposed to the three methods of teaching. It is observed in the pretest that the students have almost similar low mean scores in all methods of teaching. They got low mean scores in conceptual understanding because they did not answer the second tier questions. This further means that the students do not have background knowledge on the topics and have no confidence to try solving the problems prior to experiment. The pretest standard deviation also imply that their scores are homogeneously low. This means that the students in all groups have almost the same level of conceptual understanding before the treatment.

Table 1 also shows post test scores on the second tier questions. It can be observed that there were increase in the means scores of the students. However, there was a big gap in the mean scores of the students exposed to the two experimental methods of teaching compared to the conventional method of teaching. This means that higher scores were observed from the students in the experimental groups compared to that in the control group.

The standard deviation of the post test has increased, implying that the scores of the students became more heterogeneous. A wider increase in the spread of scores can be observed in the two experimental groups compared to the control group.

Table 2: One-way ANCOVA Summary for Students' Conceptual Understanding

Source	Adj. SS	df	Mean square	F	p-value
Treatment within	1749	2	874.44	15.10	0.0001
Error	4805	83	57.89		
Total	6554	85			

**Significant at 0.05 level*

Table 2 shows the analysis of covariance of pre-test and post-test scores of students' conceptual understanding of the experimental groups and the control group. The analysis yielded a computed probability value which is less than 0.05 level of significance. This led to the rejection of the null hypothesis. This means that there is a significant difference in the students' conceptual understanding between the two experimental groups and the control group. This implied that experimental groups' scores were significantly higher than that of the control group's scores.

Table 3: Tukey Pairwise Comparison of the Students Conceptual Understanding as Affected by the Three Methods of Teaching

Groups	N	Mean	Grouping
Conventional	29	11.39	B
LGE	29	21.81	A
PP	29	19.66	A

**means that do not share the same letter are significantly different*

To determine further which experimental group made a significant difference in the students conceptual understanding, the Tukey test was performed. Table 3 shows that both the learner generated examples method and the problem posing method of teaching are significantly different compared to the conventional method of teaching. It is implied also that learner generated examples and problem posing have the same effect on the development of conceptual understanding of the students.

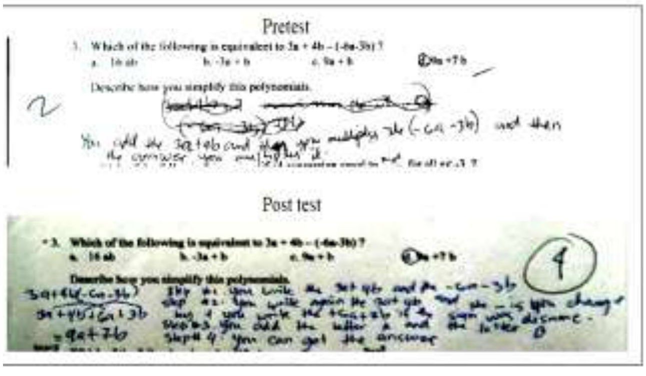

Figure 1. Pretest and posttest answers of item number 3 by student (Lg44fLCU) from the experimental group exposed to learner generated examples.

Content analysis of the students answers on the pretest and post test shows that students had improved in terms of conceptual understanding as shown in their answers in the second-tier questions in Figure 1. The student became more competent and gave proper justifications to her answers which showed that she was able to make connections and had applied learned concepts in mathematics. In question item number 3 the student exposed to learner generated examples have shown in her posttest the solutions and made a step by step procedure how she got the answer.

Whereas compared to her answer in the pretest she have not yet developed a method and procedure how to approach the problem.

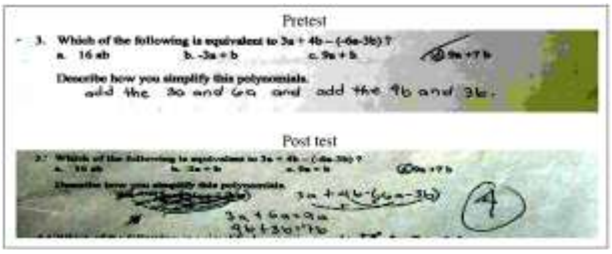

Figure 2. Pretest and posttest answers of item number 3 by student (Pg84fLCU) from the experimental group exposed to problem posing.

It can be observed that the student in the experimental group exposed to problem posing method showed better conceptual understanding as seen in the post test. In problem 3 student (Pg84fLCU) the student is confident in justifying her answer when she multiplied a negative sign to the different terms inside the grouping symbol before combining similar terms. Compared to her answer in the pretest, she did not give justification why she have to combine similar terms as if ignoring the negative signs attached to the terms inside the grouping symbol.

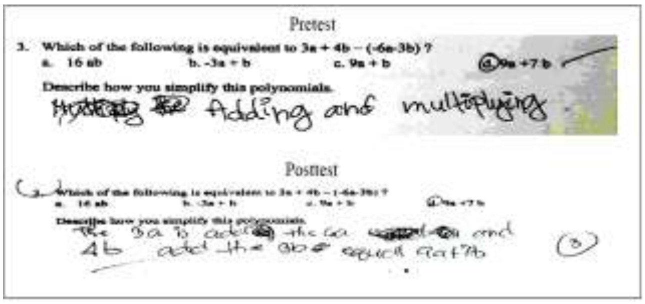

Figure 3. Pretest and posttest answers of item number 3 by student (Cg25fLCU) from the experimental group exposed to conventional method of teaching.

In the control group however, the student showed understanding of the concept but has less comprehension. Student (Cg25fLCU) neglect to show necessary details how she come up with her answer. Compared to the pre test, she answered correctly the posttest but there is a possibility that she cannot answer the problem if there were no choices considering that she neglected to emphasize the multiplication of negative sign in her explanation.

These results confirmed the claimed of Zaskis and Leikin(2007) and Watson and Shipman (2008) that LGE developing students' example space, and providing students with experiences and activities help them construct generalization of the concepts. Also these proved Watson and Mason (2001) conjecture that students remember and appreciate the importance of conditions, that were necessary stimulus to construct examples.

The results also agreed with Brown and Walter (2005;1993), Cunningham (2004), Lavy and Shriki (2007), Tan (2015), Pinter (2012), and Khan (2015) findings that problem posing can develop the mathematical knowledge and problem posing skill which even enhanced students' critiquing skills. It also developed students to be more precise and concise in formulating new problems.

6. CONCLUSIONS AND RECOMMENDATIONS

Based on the findings of the study the researcher concludes that learner generated examples as well as problem posing develops better the students' conceptual understanding of mathematics. Hence, the researchers recommend the use of learner generated examples and problem posing as a method of teaching. A combination method of problem posing and learner generated examples can also be studied to compare the result with the stand alone method. Similar studies may be conducted to wider scope using different population in different academic institution for better generalizability of the results

ACKNOWLEDGEMENTS

The researcher would like to express their gratitude to Ms. Hadji Aina Pizzimalao P. Macabanding, the principals of the Mindanao State University-Wao Community High school who allowed the conduct of the experiment in her school.

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