Merle L. Junsay[1], Ph.D.
Central Philippine University, Jaro, Iloilo City
Philippines

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REFLECTIVE LEARNING AND PROSPECTIVE TEACHERS' CONCEPTUAL UNDERSTANDING, CRITICAL THINKING, PROBLEM SOLVING, AND MATHEMATICAL COMMUNICATION SKILLS

Summary: This is a quasi-experimental study that explored the effects of reflective learning on prospective teachers' conceptual understanding, critical thinking, problem solving, and mathematical communication skills and the relationship of these variables. It involved 60 prospective teachers from two basic mathematics classes of an institution of higher learning. There were two treatments used in the study: the lecture-discussion approach and reflective learning approach of teaching. The lecture-discussion involved five phases: introduction, presentation, comprehension, monitoring, integration, and review and closure. The reflective learning approach involved initializing, exploring, and connecting processes. Validated and reliability-tested researcher-made tests on conceptual understanding, critical thinking, problem solving, and mathematical communication skills served as the instruments. The study reveals that the scores of prospective teachers exposed to the reflective learning and the lecture-discussion approach were below 50% of the perfect score before and even after intervention. It further shows that the prospective teachers' conceptual understanding, critical thinking, problem solving and mathematical communication skills significantly improved in the reflective learning group, and in the lecture-discussion group. However, the mean gains of both groups are significantly different in favour of the reflective learning group in all the aforementioned skills except in critical thinking. Furthermore, the prospective teachers' conceptual understanding, critical thinking, problem solving, and mathematical communication skills were all found to be significantly related in the reflective learning group. However, in the lecture-discussion group, only the following pairs were significantly related: conceptual understanding and mathematical communication skills; conceptual understanding and problem solving skills; and problem solving and mathematical communication skills.

Keywords: reflective learning, mathematical skills.

Introduction

The Trends International Mathematics and Science Studies (TIMSS) 2003 spelled out very dismal evidence of how the Philippines fared with other countries (Gonzales et. al, 2004). The Philippines lagged behind at the 41st spot out of 45 participating countries. In a study among high school students in the Philippines with special curriculum in 2008, TIMSS advanced results showed that, in general, Philippines performed least among 10 participating countries

[1] merle_lorca@yahoo.com

in mathematics over all. This poor performance was also observed in specific content areas and cognitive domains in terms of average scale score and percentage of correct responses (Ogena, Lana, and Sasota, 2010).

The TIMSS results are backed up by various local studies that show Filipino students' poor performance in mathematics. A study by Udquim (2010) showed that students have low mastery of skills in basic mathematics. The same results were found by Andaya (2014), on the mathematics performance of Bachelor of Elementary students when she found that achievement of students in mathematics courses is poor both in Fundamental Mathematics and Contemporary Mathematics. This finding showed a dismal and alarming reality of the mathematics competencies of those who intend to teach and those who will eventually become teachers themselves.

Among the mathematical skills that students need to master, conceptual understanding, critical thinking, problem solving, and mathematical communication skills are some of the important skills that students have mastered the least. This was true even in the early 1980s where students could only cope with the simplest of the levels assigned to describe understanding of concepts (Pascua, at al., 1987).

The study of Ganal and Guiab (2012) showed that students have problems relating to teachers' instructions, specifically on the areas of motivation, introduction, and creativity to adapt his or her method to the learner's capability. These are some of the reasons that only few students like mathematics no matter how convincing the opportunities would be for mathematically inclined students, and even if it is clear that students who have inadequate knowledge of mathematics would be greatly disadvantaged especially in this highly competitive and modernized world. Indeed, to alleviate this problem, this clearly calls for teacher's creativity in the classrooms to apply appropriate teaching strategies.

In the mathematics framework of the K to 12 Curriculum, reflective learning and constructivism are highly emphasized frames for critical thinking and problem solving (SEAMEO-INNOTECH, 2012). These frames call for teaching and problem solving methods that require the use of reflective thinking, which promotes deeper learning and optimizes students' awareness as they are structuring and constructing knowledge. These approaches should allow students to make sense of their experiences as they think and process these experiences.

Amidst difficulty in learning mathematics, reflective learning is a tool that each student should practice, reflective learning is a tool that each student should practice habitually for it is through the process of reflection that students think and organize their internal thoughts as they think of the process involved while learning. This process is called metacognition (Urquhart, 2009). Moreover, in the same study (Urquhart, 2009), it found that reflective writing supports mathematical reasoning and problem solving and helps students internalize the characteristic of effective communication.

Literature Review

Constructivist theories espoused and emphasized that students learn more if they are actively involved in the construction of knowledge (Bruner, 1977). Kolb (1984), on the other hand, proposed that knowledge is created through the transformation of experience, and this

knowledge results from the combinations of grasping and transforming experience. This is what he called Experiential Learning where concrete experience provides the information that serves as basis for reflection. From these reflections, students assimilate the information and form abstract concepts. Students use these concepts to develop new theories about the world, which they can actively test.

Modern thinkers such as Willingham (2010), a professor of cognitive psychology, had quite a deep idea of how students learn. He asserted that humans have a clear proclivity to learn and everyone is fully capable of understanding arithmetic procedures, algebra, geometry, probability, and K-12 mathematics deeply enough to allow application to problems in real-life situations. Willingham supposed that humans are born with two ways to appreciate numbers. The first one is an approximate number sense, which may not support precise enumeration but enables one to compare two sets of objects. The other way is that humans have a way of representing precise values, but only up to the value of three. An example of which, is a case of 10-month old infants who watch as one cracker is put into one bucket and then two crackers are put in another bucket. These infants crawl to the bucket with two crackers.

A study by Alibali, Stephens, Brown, Kao and Nathan (2014) entitled "Middle School Students' Conceptual Understanding of Equations: Evidence from Writing Story Problems" had found two broad areas of concern in students' conceptual understanding. First, they found that students' errors showed that they were weak in their conceptual understanding of some arithmetic operations especially in multiplication. Second, students' errors indicated that they had difficulties combining multiple operations into coherent stories as shown in their story writing. The students often simply avoided generating story actions for two-operator equations and frequently simplified their task by generating stories that reflected simpler, result-unknown situations. Clearly, these findings suggest that students found it difficult to integrate multiple mathematical operations (Alibali, et. al., 2014).

The report of the Association of American Colleges and Universities (AACU, 2005), which was based on Educational Testing Services standardized assessments from 2003 to 2004, showed that only 6% of the undergraduate seniors demonstrated critical thinking proficiency. This result showed that there is indeed a great discrepancy on what students should possess and what the real score in critical thinking is.

Elder and Paul (2010) presented a comprehensive way of describing evidence of students having critical thinking skills. They said that if students internalize the full-range of critical thinking competencies, they will be more self-directed, self-disciplined, and self-monitored thinkers.

Wheatley (1992) emphasized the importance of reflection in mathematics learning as he said that learners move beyond being "in the action" when they engage in reflection. Banker (2004) opined that reflective pedagogy in mathematics classroom leads to deeper understanding of the subject matter and teachers who provide opportunities for students to communicate about mathematics cultivate a supportive and non-threatening environment.

A comprehensive effect of using journals to students' mathematical communication skills was investigated by Koirala (2002). He found that journals do not only improve students' mathematical understanding, but also are a powerful means of communication and reflection which eventually leads to an improved mathematical reasoning.

Research Hypotheses

1. There are no significant differences in the pre-test scores in conceptual understanding, critical thinking, problem solving, and mathematical communication skills between the prospective teachers who underwent the lecture-discussion approach and those who underwent reflective learning approach.
2. There are no significant differences in the post-test scores in critical thinking, conceptual understanding, problem solving and mathematical communication skills between the prospective teachers who underwent the lecture-discussion approach and those who underwent the reflective learning approach.
3. There are no significant differences in the prospective teachers' conceptual understanding, critical thinking, problem solving and mathematical communication skills before and after exposure to the (a) lecture-discussion approach and (2) reflective learning approach.
4. There are no significant differences in the mean gain scores in the conceptual understanding, critical thinking, problem solving, and mathematical communication skills between the prospective teachers who underwent lecture-discussion approach and those who underwent reflective learning approach.
5. There are no significant relationships among the conceptual understanding, critical thinking, problem solving, and mathematical communication skills of the prospective teachers after their exposure to the (1) lecture-discussion approach and (2) reflective learning approach).

Methodology

This study determined the effects of reflective writing to the prospective teachers' critical thinking, conceptual understanding, problem solving, and mathematical communication skills. To achieve this end, a quasi-experimental pre-test - post-test control group design was employed.

Such design was applied because random assignment was quite impossible when intact groups were involved (Fraenkel & Wallen, 2009). In this study, the prospective teachers were matched according to sex, preliminary, and midterm examination results. The assignment as to what group would be under reflective writing and lecture-discussion was done randomly. The entire class, rather than individual participants were randomly assigned to treatments (Gay & Airasian, 2000), after which, the individuals receiving one treatment were matched with individuals receiving the other treatment.

Matching	Experimental Group	Pre-test	Reflective Learning	Post-test
		Pre-test	Lecture-discussion	Post-test

Figure 1. Quasi-experimental research paradigm

In the study, both the experimental and control groups took the pre-test. Then, the experimental group was exposed to the reflective learning approach while the control group was exposed to the lecture-discussion approach. Post-tests then followed for both groups after the intervention.

The Participants. The participants were first year prospective teachers of a Christian institution of higher learning. They took Mathematics 2 (Basic Math) during the first semester of the school year 2014-2015. Out of five sections enrolled in the course, only two sections composed of 40 prospective teachers were chosen primarily because of three reasons: the two sections utilized only one room; the schedule of classes were successive; and only one teacher (the researcher) handled the two classes. Since this study applied the matching of participants, the prospective teachers were matched according to sex, preliminary [$t(29)=0.560, p=.578$] and midterm [$t(29)=-0.13, p=.897$] examination results. Only those pairs considered as matched were included in the results of the study.

Table 1. Distribution of Participants per Group

Sex	Reflective Learning Group		Lecture-Discussion Group	
	f	%	*f*	%
Male	4	13.33	4	13.33
Female	26	86.67	26	86.67
Total	30	100.00	30	100.00

Instrumentation

The study involved researcher-made tests, which underwent content validation, item analysis, and reliability testing. The same instruments were utilized for both the pre-test and the post-test. The only difference is the arrangement of the items and also the arrangement of the choices in the multiple-choice questions. All the tests underwent content validation by four experts in mathematics. All questions underwent content validation, item analysis, and reliability testing through Kuder-Richardson ($r_{KR20}=.85$).

Conceptual understanding test.A 20-item multiple choice questions and ten-performance-based tasks. The prospective teachers' scores in conceptual understanding were classified as accomplished (46-60); competent (31-45); developing (16-30); and beginning (0-15).

Critical thinking test. Originally, it had 20 questions, but after several pilot tests, 12 questions remained and were used as the multiple-choice questions. The prospective teachers' scores in critical thinking were classified as accomplished (10-12); competent (7-9); developing (4-6); and beginning (0-3).

Problem solving test. It was composed of 18 multiple choice questions and seven performance-based tasks. Each item in the performance-based tasks merited a highest score of 4 points. The prospective teachers' scores in problem solving were classified as accomplished (36-46); competent (25-35); developing (13-24), and beginning (0-12).

Mathematical communication test. There were 15 performance - based tasks in which prospective teachers answered what is asked for in the problem. The prospective teachers' scores in mathematical communication skills were classified as accomplished (46-60); competent (31-45); developing (16-30); and beginning (0-15).

Results and Implications

Hypothesis 1. There are no significant differences in the pre-test scores in conceptual understanding, critical thinking, problem solving, and mathematical communication skills between the prospective teachers who underwent the lecture-discussion approach and those who underwent reflective learning approach.

Table 1. Pre-test Scores in Conceptual Understanding, Critical Thinking, problem solving and Mathematical Communication of the Prospective Teachers

	Lecture-Discussion Approach				Reflective Learning Approach			
	n	SD	M	Interpretation	n	SD	M	Interpretation
Conceptual Understanding	30	4.52	9.07	beginning	30	5.12	10.40	beginning
Critical Thinking	30	1.50	3.57	developing	30	1.71	3.63	developing
Problem Solving	30	3.87	8.67	beginning	30	4.19	9.90	beginning
Mathematical Communication	30	5.68	7.97	beginning	30	7.16	7.80	beginning

As a whole, based on the pre-test results in all areas, the prospective teacher from both teaching approaches had beginning level of conceptual understanding, problem solving, and mathematical communication skills. In the critical thinking test, the prospective teachers belong to the developing level for both groups.

Hypothesis 2. There are no significant differences in the post-test scores in critical thinking, conceptual understanding, problem solving and mathematical communication skills between the prospective teachers who underwent the lecture-discussion approach and those who underwent the reflective learning approach.

Table 2. Post-test Scores in Conceptual Understanding, Critical Thinking, problem solving and Mathematical Communication of the Prospective Teachers

	Lecture-Discussion Approach				Reflective Learning Approach			
	n	SD	M	Interpretation	n	SD	M	Interpretation
Conceptual Understanding	30	7.55	20.70	developing	30	9.88	25.43	developing
Critical Thinking	30	1.79	5.20	developing	30	1.62	5.93	developing
Problem Solving	30	6.27	18.30	developing	30	7.62	22.43	developing
Mathematical Communication	30	9.51	16.67	developing	30	12.22	21.47	developing

As a whole, the results seem to suggest that although the prospective teachers' performance had improved for both the lecture-discussion and reflective learning group, their scores were still low and behind the passing score in each of the skills measured. Aside from the prospective teachers' poor mastery of the content, one probable reason for this dismal result may be the prospective teachers' exposure to the type of test given by the teacher. Questions which measure the prospective teachers' conceptual understanding, critical thinking, problem

solving and mathematical communication skills assessed the prospective teachers' meaningful learning and went beyond rote learning.

Hypothesis 3. There are no significant differences in the prospective teachers' conceptual understanding, critical thinking, problem solving and mathematical communication skills before and after exposure to the (a) lecture-discussion approach and (2) reflective learning approach.

3.1. Lecture-discussion Approach

Table 3. Difference in the Scores in Conceptual Understanding, Critical thinking, Problem Solving, and Mathematical Communication Skills of the Prospective Teachers before and after undergoing the Lecture-discussion Approach

	df	M	SD	Mean Difference	t	p
Conceptual Understanding						
Pre-test	29	9.07	4.52	11.63	12.20***	.000
Post-test		20.70	7.55			
Critical Thinking						
Pre-test	29	3.57	1.50	1.63	5.42***	.000
Post-test		5.20	1.79			
Problem Solving						
Pre-test	29	8.67	3.87	9.63	13.07***	.000
Post-test		18.30	6.27			
Mathematical Communication						
Pre-test	29	7.97	5.68	8.70	9.25***	.000
Post-test		16.67	9.51			

Note***p<.001

Conceptual understanding. The mean difference of 11.63 ($M_{pretest=}$ 9.07, $M_{posttest=}$ 20.700) was found to be significant, t (29)= -12.20,p=.000. This result implies that there was an improvement in the scores of the prospective teachers in conceptual understanding.

Critical Thinking Skill. It is shown that there was an improvement in the mean scores of 1.63 ($M_{pretest}$=3.57,$M_{posttest}$=5.20). This mean difference was verified to be significant, t (29)=5.42, p=.000, which implies that the prospective teachers' performance in critical thinking had significantly improved.

Problem Solving Skill. A big leap (mean difference of 9.63) was evident in the scores of the prospective teachers under the lecture-discussion approach, ($M_{pretest}$=8.67, $M_{posttest}$=18.30). This huge difference was found to be significant, t (29)= 13.07,p=.000. This means that for the prospective teachers who were exposed to the lecture-discussion approach, there was a significant improvement in their mean scores in problem solving in pre-test and post-test.

Mathematical Communication Skill. It is shown that the prospective teachers' mean score improved ($M_{pretest}$=7.97,$M_{posttest}$=16.67). Such improvement showed more than 100% (mean difference of 8.70) increase. Consequently, this mean difference was significant, t (29)=9.25,p=.000. This result implies that the post-test scores of prospective teachers in mathematical communication were significantly higher than their scores in the pre-test.

3.2. Reflective-learning Approach

Table 4. Difference in the Scores in Conceptual Understanding, Critical thinking, Problem Solving, and Mathematical Communication Skills of the Prospective Teachers before and after undergoing the Reflective-learning Approach

	df	M	SD	Mean Difference	t	p
Conceptual Understanding						
Pre-test	29	10.40	5.12	15.03	10.40***	.000
Post-test		25.43	9.88			
Critical Thinking						
Pre-test	29	3.63	1.71	2.30	6.52***	.000
Post-test		5.20	1.79			
Problem Solving						
Pre-test	29	9.90	4.19	12.53	12.04***	.000
Post-test		22.43	7.62			
Mathematical Communication						
Pre-test	29	7.80	7.16	14.67	11.34***	.000
Post-test		22.47	12.22			

Note***p<.001

Conceptual Understanding. The result showed that there was a mean difference of 15.03 or an increase of more than 150% ($M_{pretest}$=10.40, $M_{posttest}$=25.43). Obviously, this big mean difference was significant, t (29)=10.40,p=.000. hence, there was a significant improvement in the scores of the prospective teachers after they were exposed to the reflective learning approach.

Critical Thinking Skill. The results showed that there was also an improvement in the mean scores of 2.30 ($M_{pretest}$= 3.63, $M_{posttest}$=5.20). This improvement in score was significant, t (29)= 6.52,p= .000, which means that, indeed, the scores of the prospective teachers in critical thinking had significantly increased having been exposed to the reflective learning approach of teaching.

Problem Solving Skill. The prospective teachers' pre-test mean score (M=9.90) had more than doubled in the post test (M=22.43). A mean difference of 12.53 was found to be significant, t (29)= 12.04, p=.000. therefore, the prospective teachers who were exposed to the reflective learning approach had a significant improvement in their problem solving skill.

Mathematical Communication Skill. A significant increase of 14.67 ($M_{pretest}$=7.80, $M_{posttest}$=22.47) showed that the pre-test score had tripled in the post-test which consequently was verified to be significant, t (29)=11.34,p=.000. This result implies that the prospective teachers' performance in mathematical communication had significantly improved.

Hypothesis 4. There are no significant differences in the mean gain scores in the conceptual understanding, critical thinking, problem solving, and mathematical communication skills between the prospective teachers who underwent lecture-discussion approach and those who underwent reflective learning approach.

Table 5. Difference in the Mean Gain Scores in Conceptual Understanding of the Prospective Teachers who underwent the Lecture-discussion Approach and the Reflective-learning Approach

	Mean Gain	SD	Mean Difference	df	t	p
Teaching Approach						
Lecture-discussion	11.63	5.22	3.40	29	2.15*	.040
Reflective Learning	15.03	7.92				

Note. *p<.05

It is shown that the mean gain scores of the prospective teachers in conceptual understanding exposed to the reflective learning approach (Mgain=15.03) was higher by 3.40 than the mean gain of the scores of prospective teachers exposed in the lecture-discussion approach (Mgain=11.63). This difference was found to be significant, to (29)= 2.15,p=.40. Clearly, it is shown that the reflective learning group had higher mean gain score in conceptual understanding than the mean gain score of the lecture-discussion group.

Table 6. Difference in the Mean Gain Scores in Critical Thinking Skill of the Prospective Teachers who underwent the Lecture-discussion Approach and the Reflective-learning Approach

	Mean Gain	SD	Mean Difference	df	t	p
Teaching Approach						
Lecture-discussion	1.63	1.65	0.67	29	1.43	.163
Reflective Learning	2.30	1.93				

The results showed a mean gain difference of 0.67. This is because the mean gain scores of the prospective teachers in the lecture-discussion group was 1.63, and the mean gain scores of the prospective teachers in the reflective learning group was 2.30. It appears that the difference in the mean gains of the two groups was not significant, t (29)=1.43,p=.163. This result simply means that the mean gains of the two groups were comparably the same.

Table7. Difference in the Mean Gain Scores in Problem Solving Skill of the Prospective Teachers who underwent the Lecture-discussion Approach and the Reflective-learning Approach

	Mean Gain	SD	Mean Difference	df	t	p
Teaching Approach						
Lecture-discussion	9.63	4.04	2.90	29	2.98**	.006
Reflective Learning	12.53	5.70				

Note. **p<.01

It is reflected in the table that the difference in the mean gain scores of the prospective teachers in problem solving exposed in the two approaches is 2.90 ($M_{lecture\text{-}discussion}$=9.63, $M_{reflective\text{-}learning}$=12.53). This difference was found to be significant, t (29) =2.98,p=.006. This result means that the mean gain of the prospective teachers in the reflective learning group was significantly higher than the mean gain of the prospective teachers in the lecture-discussion group.

Table8. Difference in the Mean Gain Scores in Mathematical Communication Skill of the Prospective Teachers who underwent the Lecture-discussion Approach and the Reflective-learning Approach

Teaching Approach	Mean Gain	SD	Mean Difference	df	t	p
Lecture-discussion	8.70	5.15	5.97	29	4.58***	.000
Reflective Learning	14.67	7.09				

Note. **p<.01

It is reflected in the table that there is a big and significant difference in the mean gain scores of the prospective teachers in mathematical communication skill exposed in the two approaches. It is significant at t (29)=4.58,p=.006. This result means that the performance in mathematical communication skill of the prospective teachers who underwent the reflective learning approach had better improvement than the performance of those who underwent the lecture-discussion approach.

Hypothesis 5. There are no significant relationships among the conceptual understanding, critical thinking, problem solving, and mathematical communication skills of the prospective teachers after their exposure to the (1) lecture-discussion approach and (2) reflective learning approach).

Table 9. Relationship Among Conceptual Understanding, Problem Solving, Critical Thinking, and Mathematical Communication Skills of the Prospective Teachers after their Exposure to the Lecture-Discussion Approach

Variables		1	2	3	4
1. Problem Solving		-			
2. Critical Thinking	r	.12			
	p	.529	-		
3. Conceptual understanding	r	.83***	-.03		
	p	.000	.875	-	
4. Mathematical Communication skill	r	.13***	.03	.86***	
	p	.000	.875	.000	-

Note.*** p<.001

With Pearson's r, the extent and direction of these possible relationships were determined and tested for significance at 5%. Results showed that the prospective teachers exposed to

the lecture-discussion approach had post-test scores in conceptual understanding and critical thinking that were not significantly related, r=.03,p=.875. This result might be due to the reason that under the lecture-discussion approach of teaching, the prospective teachers were exposed to natural classroom conditions with limited activities for them to participate in the construction of knowledge which in turn inhibited possible relationship between the teachers' conceptual understanding and critical thinking skills.

The prospective teachers' post-test scores in conceptual understanding and problem solving, were however found to be high and significantly related, r=.83,p=.000. This result means that among the prospective teachers who were exposed in the lecture-discussion approach, those who performed better in their conceptual understanding tend to perform better also in problem solving and vice versa.

Likewise, the relationship between the conceptual understanding and mathematical communication skillof the prospective teachers who were exposed to the lecture-discussion approach was found to be significant, r=.86,p=.006. This result means that those prospective teachers who had high conceptual understanding were likely to have high mathematical understanding and vice versa. On the other hand, the prospective teachers' critical thinking and problem solving skills were found to be not significantly related, r=.12,p=.529. This implies that for the prospective teachers who were exposed to the lecture-discussion approach, those of them who performed better in problem solving did not necessarily tend to perform better in critical thinking.

Moreover, there was a negligible and insignificant relationship between the prospective teachers' critical thinking and mathematical communication skills, r=.03,p=.875. This result means that the prospective teachers with high critical thinking skills did not necessarily have high mathematical communication skills.

On the contrary, the problem solving and mathematical communication skills of the prospective teachers were significantly related,r=.13,p=.000. The result showed that there was positively low but significant relationship between the problem solving and mathematical communication skills of prospective teachers who were exposed to the lecture-discussion method. Those prospective teachers who had high problem solving skills tend to have high mathematical skills also.

Table 10. Relationship Among Conceptual Understanding, Problem Solving, Critical Thinking, and Mathematical Communication Skills of the Prospective Teachers after their Exposure to the Reflective Learning Approach

Variables		1	2	3	4
1. Problem Solving		-			
2. Critical Thinking	r	.63***	-		
	p	.000			
3. Conceptual understanding	r	.86***	.61***	-	
	p	.000	.000	-	
4. Mathematical Communication skill	r	.78***	.48	.85***	-
	p	.000	.007	.000	-

Note.*** p<.001

As, the conceptual understanding and critical thinking skills of the prospective teachers were moderately and significantly correlated, r=.61,p=.000. Thus, for the prospective teachers who were exposed in the reflective learning approach, and had better conceptual understanding were likely to perform better in critical thinking. The prospective teachers exposed to the reflective learning strategy were actively involved in discussing, brainstorming, exploring and more importantly in reflecting which are considered important ingredients not just for conceptual understanding, but also for critical thinking.

Interestingly, the prospective teachers' conceptual understanding and problem solving skills were highly correlated which was significant, r=.86,p=.000. This shows a very high correlation between these two variables which implies that for the prospective teachers who were exposed in the reflective learning approach, those who performed better in conceptual understanding, performed better also in problem solving and vice versa.

The strength of relationship of the prospective teachers' conceptual understanding and mathematical communication skills was likewise highly correlated and significant, r=.85,p=.000. This means that there was a positively high and significant relationship that existed between these two variables. This implies that for the prospective teachers who were exposed in the reflective learning approach of teaching, those of them who had high conceptual understanding also had high mathematical communication skills.

As to the problem solving and critical thinking skills, these variables were found to be moderately correlated and significant, r=.63, p=.000. Thus,, if a prospective teacher has a high problem solving skill, he or she is more likely to have high critical thinking skills also.

Moreover, the critical thinking skills and the mathematical communication skills were moderately significantly correlated, r=.48, p=.000. This could be interpreted as, those prospective teachers who performed well in their critical thinking skills tended to perform well also in their mathematical communication skills.

Further, the problem solving and mathematical communication skills of prospective teachers' were also highly and significantly correlated, r=.78, p=.000. This relationship showed that for the prospective teachers who were exposed to reflective learning approach of teaching, those who had high scores in problem solving were lkely to have high scores also in their mathematical communication skills.

Discussion

The pre-test scores in conceptual understanding, problem solving, and mathematical communication skills of the prospective teachers in both the lecture-discussion group and the reflective learning group were at the beginning level. On the other hand, the critical thinking skill pre-test scores for both groups were one level higher (developing) although all these pre-test scores were considered way behind the passing score (half of the perfect score).

The post test scores in conceptual understanding, critical thinking, problem solving, and mathematical communication for both the lecture-discussion and the reflective learning group had shown big improvement. For all the aforementioned skills, both groups were in the

developing level and the scores of the prospective teachers were not able to reach the passing score (half of the perfect score).
The pre-test scores of the reflective learning group and the lecture-discussion group in conceptual, critical thinking, problem solving, and mathematical communication were not significantly related.

There were significant differences in the post-test scores of the prospective teachers in conceptual understanding, problem solving, and mathematical communication between those who were exposed to the lecture-discussion approach and the reflective learning approach. However, there was no significant difference in the post-test scores of the two groups in critical thinking after their exposure to the two teaching approaches.

For both the lecture-discussion and the reflective learning groups, there were significant differences in their pre-test and post-test scores in conceptual understanding, critical thinking, problem solving and mathematical communication.

There were significant differences in the mean gains in the scores of the prospective teachers in conceptual understanding, problem solving; and mathematical communication between those who were exposed in the lecture-discussion and the reflective learning approach. On the other hand, between the two groups, there was no significant difference in the mean gain scores in critical thinking.

For the lecture-discussion group, there was a significant relationship between the conceptual understanding and problem solving skill; conceptual understanding and mathematical communication skill; and problem solving and mathematical communication skill of the prospective teachers. However, for the same group, there was no significant relationship between the scores in conceptual understanding and critical thinking; critical thinking and problem solving and; critical thinking and mathematical communication skill.

For the reflective learning group, there was a significant relationship between the conceptual understanding and critical thinking skill; conceptual understanding and problem solving skill; conceptual understanding and mathematical communication skill; critical thinking and problem solving skills; critical thinking and mathematical communication skills; and problem solving and mathematical communication skills.

Conclusion

The prospective teachers did not possess adequate conceptual understanding, critical thinking, problem solving, and mathematical communication skills before their exposure to the lecture-discussion approach and the reflective learning approach.

Although the post-test scores in conceptual understanding, critical thinking, problem solving, and mathematical communication skills for the lecture discussion group and the reflective learning group showed big improvement, the prospective teachers were not able to pass the tests to measure the aforementioned skills. They were short of the ability to apply concepts, and mathematical principles; they lacked the ability to analyse, evaluate, interpret, infer, explain and self-regulate; they needed to enhance their skill to solve problems; and they were deficient in expressing their ideas mathematically.

The prospective teachers from the reflective learning group and the lecture-discussion group were comparable in their conceptual understanding, critical thinking, problem solving and mathematical communication skills before their exposure to the teaching strategies. That is, the design was appropriate to be applied for this study since the two groups had the same levels of the skills mentioned before the intervention.

The prospective teachers who were exposed to the reflective learning approach were better off in understanding mathematical concepts; had better problem solving abilities; and had better facility in expressing their ideas mathematically than those who were exposed to the lecture-discussion approach. However, prospective teachers who were exposed to the reflective learningapproach were as good as in analysing, evaluating, interpreting, inferring, explaining, and self-regulating as those prospective teachers who were exposed to the lecture-discussion approach.

Both the lecture-discussion and the reflective learning as teaching approaches effectively enhanced the prospective teachers' performance in conceptual understanding, critical thinking, problem solving, and mathematical communication.

The reflective learning teaching approach was a better approach than the lecture-discussion approach in improving the conceptual understanding, problem solving, and mathematical communication skills of the prospective teachers. However, the reflective learning approach was as good as the lecture-discussion approach in developing the critical thinking skills of the prospective teachers.

The prospective teachers who were exposed to the lecture-discussion approach had the following performances that were related: conceptual understanding and problem solving skill; conceptual understanding and mathematical communication skills; and problem solving skills and mathematical communication skills. However, for the same group of prospective teachers, their performances in conceptual understanding and critical thinking; critical thinking and problem solving, and critical thinking and mathematical communication skills were not related

Reflective learning, as experienced by prospective teachers in this study, is consistent with the idea of constructivism as espoused by Bruner (1977). Constructivism focused on the learner as the key player in the generation of knowledge. In the process of reflective learning, the prospective teachers were actively involved in structuring, brainstorming, discussing, writing, proposing, inventing, and formulating valuable ideas for learning. The prospective teachers' active participation in the teaching and learning process was indeed optimized in reflective learning for the prospective teachers were given the control of their own learning process as they reflect about their experiences while they learn. Likewise, the prospective teachers were also exposed to working by groups for them to discuss and experience group reflection, which is a characteristic of constructivism.

The results of the study are likewise a confirmation of the Experiential Learning Theory by Kolb (1984). This theory acknowledges the importance of concrete experience as basis for reflection, which the prospective teachers utilized to assimilate the information and form abstract concepts. Without a doubt, reflective learning had provided the prospective teachers enough experience in the classroom that would lead them to reflect and learn from these experiences since reflective learning had been found to be effective in improving the

prospective teachers' conceptual understanding, critical thinking, problem solving, and mathematical communication skill.

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***Biographical notes*:**

Dr. Merle L. Junsay is currently the Dean of the College of Education of Central Philippine University, Iloilo City Philippines. She finished her Doctor of Philosophy in Science Education Major in Mathematics at West Visayas State University and her Master's in Education Major in Mathematics at the University of the Philippines, Visayas. She is a graduate of Bachelor in Secondary Education major in Mathematics and she teaches statistics, mathematics and professional education subjects in the undergraduate programs of the University.