Activity-Based Teaching of Integer Concepts and its Operations

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Abstract: Students often have difficulty with the concept of integers which makes them struggle when they algebraic solve equations. This action research study focuses on data gathered in a seventh grade mathematics class. The researchers analyzed the effect of various activities using models of integers like the Target integer, Integer chips, the use of Damath and an online game Number Cruncher. The results assessed students' conceptual understanding, procedural skills and perception. These activities led to a greater increase in students' performance and conceptual understanding on integers. Results were compared using the same assessment tool, Pre-Post Tests. Student interviews and surveys were conducted. The combination of these data sets suggests that students' conceptual understanding and procedural skills are enhanced when activity-based teaching is used.

Key Words: up to five key words/terms; separated by semicolons

1. INTRODUCTION

Many students enter high school level with severe gaps in their concepts and skills in mathematics. One of these basic foundational knowledge and skills is the integers, a necessary pre-requisite skill to solve equations. Performing operations on integers involves signs of the numbers and the signs of required operation. This makes students get confused and struggle when asked to perform operations on integers (Muñoz, 2010). It is specially difficult when students are taught to follow rules and procedures in a very abstract manner without going through models for better conceptual understanding.

1.1 Conceptual Understanding

Conceptual mathematics understanding as a knowledge, involves thorough understanding of underlying and foundational concepts behind the algorithms performed in mathematics (Rille-Johnson, et al, 2001).

The U.S. National Research Council (2001) explains that conceptual understanding develops when students see the connections among concepts and procedures and can give arguments to explain why some facts are consequences of others.

1.2 Procedural Skills

On the other hand, procedural mathematics understanding is a knowledge that focuses on skills and step-to-step procedures without explicit reference to mathematical ideas (Hope, 2006). Tall

(2008) adds that procedures need to be translated into an overall process that can be manipulated mentally in a flexible way.

Mere procedural skills often fail to provide readily applicable methods to solve mathematics problem. As Wilkins (2000) espoused, a student must have both conceptual understanding and procedural skills if they were to understand mathematics in depth. Likewise, the National Mathematics Advisory Panel (2008) and the National Research Council (2001) agree that conceptual understanding is considered to be as important as procedural fluency and strategic competence. Conceptual understanding and procedural skills must go together. Mere procedural skills often fail to provide readily applicable methods to solve mathematics problem.

1.3 Use of Models

Any concept in Mathematics can be better understood when students connect these abstract ideas to concrete ones. Fenema & Franke (1992) emphasized the importance of mathematical representations in helping students connect abstract mathematics into something they can relate to and understand. This can be achieved by providing models to represent these concepts.

1.4 Use of Active Learning Strategy

To explore the world of mathematics would involve a lot more than merely listening to a lecture. When students do hands-on and minds-on activities, they can better attain conceptual understanding and procedural fluency. According to Lakshmi (2005), most of the classes are held in a traditional monologue session where the teacher does all the talking and the students are passive audience. Little is known to the teacher on the amount of knowledge consumed by the students. Unless the student seriously pay attention to the key points delivered, there is definite reason for knowledge to escape into thin air.

1.5 Use of Manipulatives

The use of concrete material in the teaching and learning of mathematics makes the abstract subject interesting and real. Manipulatives are concrete objects used to help students understand abstract concepts in the domain of mathematics (McNeil & Jarvin, 2007). The use of these tools in teaching entails teacher's good purposeful planning and skills. The use of manipulatives provides teachers with great potential to use their creativity to do further work on mathematics concepts as an alternative to merely relying on worksheets (Furner, et al, 2005). The idea that children learn best through interacting with concrete objects has sparked much interest in the use of mathematics manipulatives, which are concrete objects that are designed specifically to help children learn mathematics (Ball, 1992).

A study by Samo (2008) confirms that, activity based teaching is potent strategy for teaching mathematics, it can create interest in the subject. Furthermore, if the activities relate with real life situation, and students own experiences, that helps more in their conceptual understanding. In addition, the author stated that students learn mathematics by constructing their own conceptual understanding. They learn mathematics by an active participation, and their active participation can be insured by good teaching strategies and by creating their interest in the classroom, for these purpose teachers can use activities, concrete material and students' prior knowledge.

1.5 Use of Manipulatives

The use of technology can be a powerful teaching and learning tool. Available to us in the World Wide Web are tools referred to as "virtual manipualtives"(Moyer, et al, 2002). These are dynamic visual representations of concrete manipulatives. They are interactive and allow the learner to manipulate the virtual object as you would a concrete manipulative. One can turn and flip the virtual objects. Researches (Wright, 1999, Kerrigan, 2002) reveal positive effects on teaching and learning when technology is used to its fullest potential.

1.6 The Problem Statement

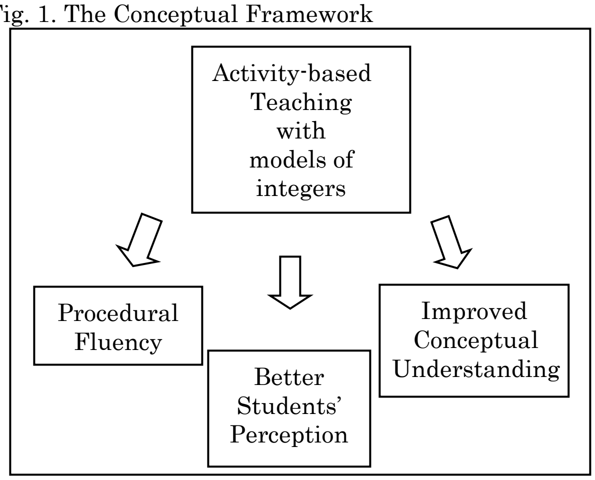
The main purpose of this study was to look at the grade 7 students' perception, procedural skills and conceptual understanding of integers and their operations through activity-based teaching using models for integer concepts and its operations. Specifically, it sought to answer the following:

1. What are the students' conceptions and procedural skills in operations on integers
   a. prior to the activity-based teaching?
   b. after the activity-based teaching?
2. Is there a significant difference between the students' conceptions and procedural skills before and after the intervention?

3. What are the students' perceptions in concepts and operations on integers using activity-based teaching?

1.6 The Conceptual Framework

Fig. 1. The Conceptual Framework



When students are involved in a process of activity-based teaching using varied models of integers, it should not be purely just for fun but has to be effective in developing students' conceptual understanding, which eventually can help them attain procedural fluency. Students in the process, find these interesting and enjoyable for a more positive perception of their mathematics learning.

2. METHODOLOGY

The study is descriptive and made use of both quantitative and qualitative methods. Data collected were used primarily to describe students' conceptual understanding, procedural skills and perceptions on integer concepts and its operations through the use of models in various activity-based interventions.

The participants consist of 37 grade 7 students in an intact class in a private sectarian school in Manila.

A questionnaire modified from Muñoz (2010) was used as a pre-test and post-test. This is a 40-item test that assessed students' conceptual understanding and procedural skills on integers. Twenty-four (24) of these items checked on students' conceptual understanding and sixteen (16) items on procedural skills. Item numbers 1 to 6 are true or false test that deals with concepts of number line, e.g., "Opposite integers are the same distances from zero", "When subtracting, the answer can be positive". Item numbers 7 to 9 are identification, e.g. "What integer do you reach if you move 7 places to the left of 3?" Item numbers 10 and 11 require students to order integers from the least to the greatest. Item numbers 12 to 14 are on comparing integers. Item numbers 15 and 16 are on real life application. Operations on integers are found on item numbers 17 to 32. Item numbers 33 to 35 are on integer properties. Item numbers 36 to 40 are open ended questions where students explain the rules in the different operations on integers.

The original test (Muñoz, 2010) was modified using a table of specifications following the Department of Education's Minimum Learning Competencies on Integers for purposes of aligning this to the learning goals and classroom instruction. Question numbers 3, 4 and 6 of the interview were taken and modified from the intervention survey of Goracke (2009).

These instruments were validated by two College Mathematics professors and were pilot tested to 40 grade 7 students. Cronbach's alpha reliability coefficient is 0.859, considered high and acceptable.

The models used were (1) number line, (2) integer chips, (3) Damath game and (4) online game called the Number Cruncher. The number line and integer Chip models were adapted from the games by Burkhart (2007) and Flores (2008), respectively. Damath comes from the Philippine Checker board game called "dama" and mathematics. It blends local culture, education and digital technology that aim to make math teaching and learning child-friendly, challenging and interactive. This game was designed by a medal awardee teacher Jesus L. Huenda, a public high school teacher. The online game Number Cruncher gives asks students to perform a given operation by starting from a given number and going to the correct target number.

Permission to conduct the study from the school's administration was secured. Parental consent was sought and granted. The pre-test was administered for one hour to target participants. The lesson had been taken up ten days before the pre-test was administered. Then, a 1-hour interview was conducted to 10 randomly selected students to verify their answers in their pre-test. Pseudonyms are used for confidentiality.

Each of the four interventions was integrated in a one-hour session of their mathematics class.

After which, the post-test was administered and an interview of the previously randomly selected 10 students who were interviewed, to obtain their perception about the activity-based teaching. Data gathering lasted for 10 days. Answers in pre-test and post-test as well as the interview transcripts were compared, coded, tabulated and analyzed.

Students' answers in the pre-test and post-test were compared with the answer key. Each correct answer earns 2 points, partially correct 1 point and wrong answer 0 point. Procedural and conceptual gains were computed using the Hake gain formula to ascertain if there are improvements.

3. RESULTS AND DISCUSSION

3.1 Prior to Intervention

Students' conceptual understanding as shown in their pre-test (please see Fig. 2) is positively skewed, the peak of the histogram falls under the interval score of 7 to 12 where 10 students belong to this classification. The maximum data value is 19 and the minimum data value is 2. Needless to say, none of the students got higher than 19. From the 24 items under conceptual understanding, out of 37 students, only 7 of them got more than 50% items (i.e. score higher than 12) correct. If the passing score is 50%, then only 14 of them passed the test which is equivalent to 37.84%. Two students got the highest score of 19 and only one got the lowest score of 2.

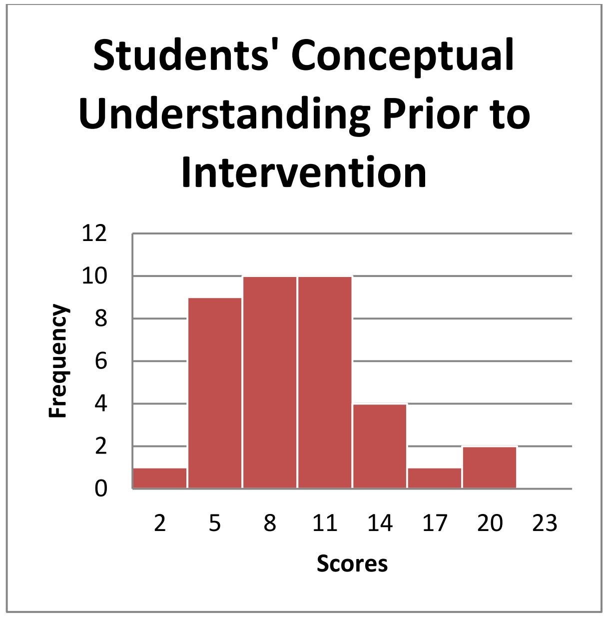


Fig. 2. Students' conceptual understanding prior to activity-based teaching

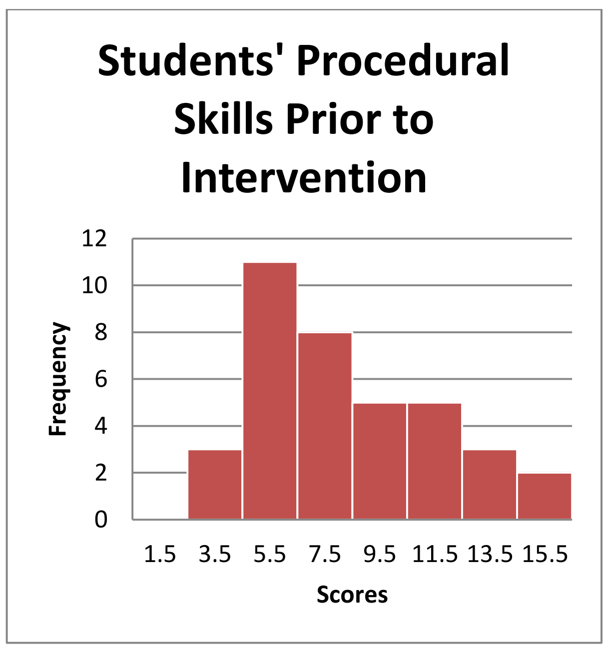


Fig. 3. Students' procedural skills prior to activity-based teaching

Figure 3 shows students' scores in the 16 item pre-test for their procedural skill. The histogram is asymmetrical in shape where it skewed to the right. The maximum data value is 16 while the minimum data value is 3. The peak of the graph is at the score interval of 5 to 6 with 11 students under this classification. The graph has no gap yet it has a plateau indicated at score interval of 9 to 12. Out of 37 students, only 18 passed the test which is equivalent to 48.65%. Two students got a perfect score and one got the lowest score of 3. These students were consistent to show that their conceptual understanding and procedural skills were both high. However, 18 students (48.65%) were found to be low both in conceptual understanding and procedural skills at the same time.

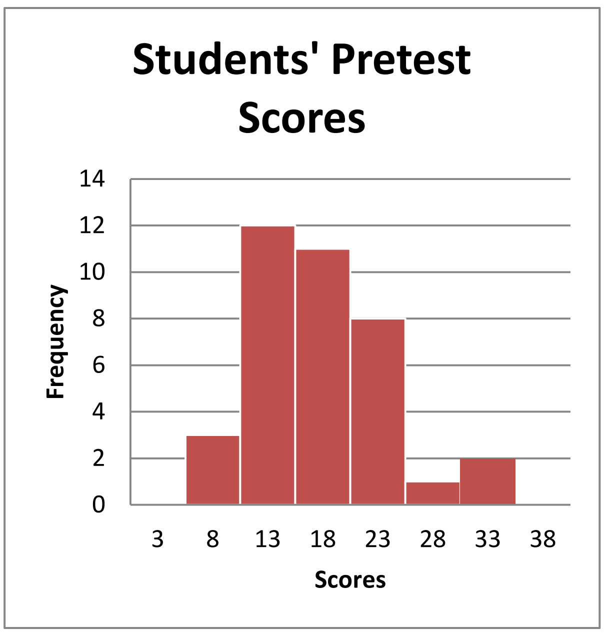


Fig. 4. Students' conceptual understanding and procedural skills prior to activity-based teaching

In Figure 4, the mode or the peak of the graph falls under the score interval of 11 to 15 with 12 students. Only 14 out of 37 students passed the entire pre-test which is only equivalent to 37.8%. On the contrary, 23 students (62.2%) failed as can be seen in a right-skewed histogram with only 2 students got a score within 31 to 40. This only shows that students' conceptual understanding and skills on integers are not well rooted as foundation of their mathematics learning.

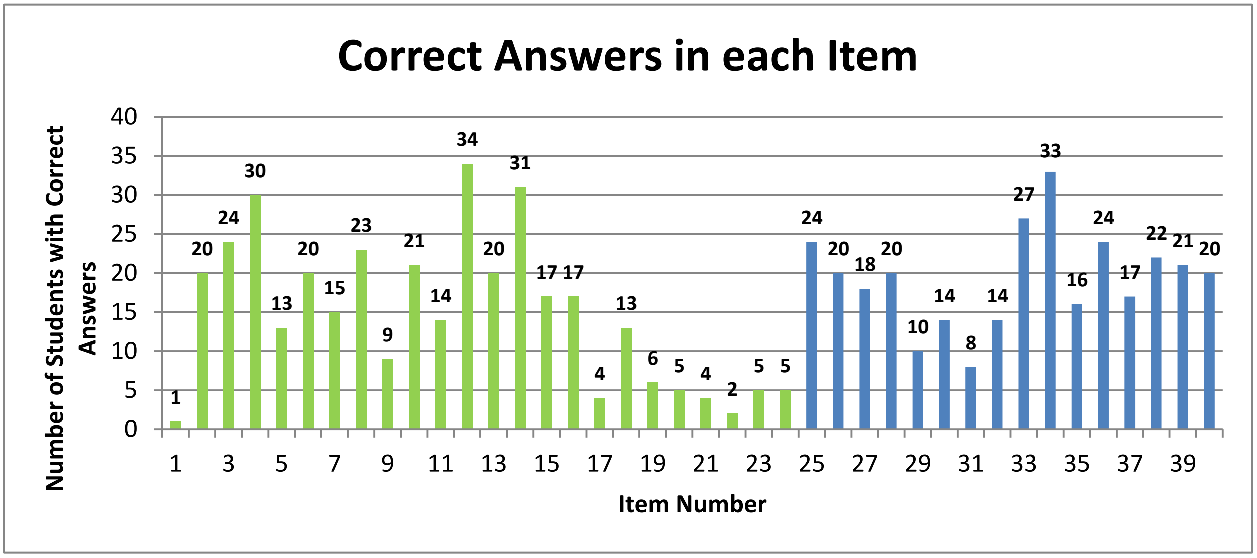


Fig. 5. Frequency of Correct Responses in the Pretest

From the result of students' conceptual understanding and procedural skills, it is also interesting to see that there are students who have low scores in conceptual understanding but obtained a higher score in procedural skills (e.g. student number 2 and number 14) or the other way around, got a high score in understanding of concepts but very poor in procedural skills (e.g. student number 36). This only shows that there might have certain factors that affect the inconsistency of these results.

Figure 5 shows the number of correct answers of students per item in the pre-test. This reveals which particular concepts and procedural skills students are poor or good at. Item numbers 1 – 24 (green-colored bar graph) are students' conceptual understanding result. Based on the figure, the following items are the concepts where students are strong at. The first item [Integers are either positive or negative], 36 (97.30%) students answered true. In item number 3, only 13 (35.14%) students disagreed on the given statement that absolute value of a number is always positive. Item number 4 [When subtracting integers, the solution can be positive] 30 students (81.08%) agreed and 7 students (18.92%) disagreed. In item number 8, 23 students (62.16%) knew that zero is neither positive nor negative while 14 students have no answers. Furthermore, students' concept about distances of integers on the number line was also low as can be seen in item number 9, only 24.32% answered correctly and 75.68% got a wrong answer. And lastly, items number 12 and 14 pertaining to integer comparison using less than, greater than and equality symbol have higher frequency of correct answers: 91.89% and 83.78% respectively.

As can be seen in the graph, the right end scale are lower particularly items number 17 to 19. These items covered the concepts of distributive, commutative and associative property where an average of only 7.67 students answered correctly. Item numbers 20 until 24 were essay questions [Explain how the answer to an addition problem can be positive, negative, or zero; and explain how the answer to multiplication and division problem can be positive, negative, or zero.] An average of only 4 students explained it correctly and there were 18.92% of the students who did not even attempt to answer the essay questions leaving their papers blank.

This implies that most of students' understanding is weak in these concepts and this could have brought about their difficulties in properties and the essay. Students have poor conceptual understanding on how the sum, product and quotient become positive, negative or zero. Majority of the participants cannot elaborate well their ideas and concepts in writing and there were also evidences of misconceptions. For example Student #8 answered: "The answer to addition can be positive, negative or zero depends on the higher value of a number." Student #13 wrote: "When a number is even then it becomes positive, negative or zero." And according to student #26: "The answer to multiplication and division becomes positive, negative or zero because of the absolute value of a number, absolute value can be positive or negative."

Items 25 – 40 are students' procedural skill result on operations of integers. Based on the graph, out of 37 students, an average of 21 (56.76%) answered correctly items number 25 to 28 which pertains to addition of integers. Items number 29 to 32 have the lowest portions of the graph, these items deal with subtraction of integers where students find it difficult particularly item number 31 that covers subtraction of integers using symbol of grouping e.g. "-7 – (-2)". An average of 12 out 37 students (32.43%) answered the items correctly. On the other hand, an average of 25 students (67.57%) answered wrongly.

This finding conforms to the work of Harris and Muñoz (2010) that students' lack of understanding on the concept and rules of subtraction of integers was the most difficult and challenging operation for students, couple this with the use of parenthesis for either subtraction or with a negative number was more confusing to them. Students appeared to just have the minimal proficiency to solve some computations and to show representations to support their answers.

As can be seen also in the graph, it is very apparent that students' procedural skills in multiplication of integers (items number 33-36) and division of integers (items number 37-40) are high having an average of 25 out of 37 students (67.57%) with correct answers in multiplication and 20 out 37 students (54.05%) performing division of integers. Moreover, the question regarding multiplication of integers by zero (item number 34) showed 89.19% of the students got it correctly, however there were still 10.81% who had wrong concept that any integer multiplied to zero is always zero.

For triangulation purposes, the researchers interviewed 10 students about their understanding of integers. The interviewees were given three questions and the results show that for question number 1 [What is your idea about integers?], 60% of the students already knew that integers are whole, positive, and negative numbers. They have the idea to which integer is greater than the other base on number 2 question which is consistent to the result of the pre-test under conceptual understanding item number 12 and 14. Many students expressed that they did not know anything about integers or they just remembered that integers are positive and negative numbers only. Based on the responses of ten students answering the first three questions, it is evident that 9 out of 10 have no idea about absolute value which is consistent and supported the lower result of the pre-test particularly in item number 3. Six out of 10 students based their knowledge of a positive and negative numbers on its position in the number line. Nine out of 10 know that positive is greater than negative numbers. And 3 out of 10 students already forgot the idea of integers.

In addition, there were misconceptions on the concepts of absolute value, distances and signs of integers based on its position on the number line: e.g."Absolute value is when multiplying or dividing numbers and the answer stays the same", "Numbers are positive if it is far away from zero and numbers are negative if it is near zero" and "By using number line, of course numbers that are near zero are positive".

3.2 Post-Intervention

After the participants went through the various interventions using models of integers, the results in Figure 6 show that, students' conceptual understanding scores increased. The shape of the histogram is positively skewed. Fifteen (15) students got a score ranging from 16 to 18 where the peak of the graph is located and only one student got the lowest score of 12. There is no gap in the graph and no extreme values at the same time. The peak of the graph suggests that the bulk of the population of students is located above the passing rate (score of 12). All participants passed the 24-items test on concepts of integers and five of them got perfect score.

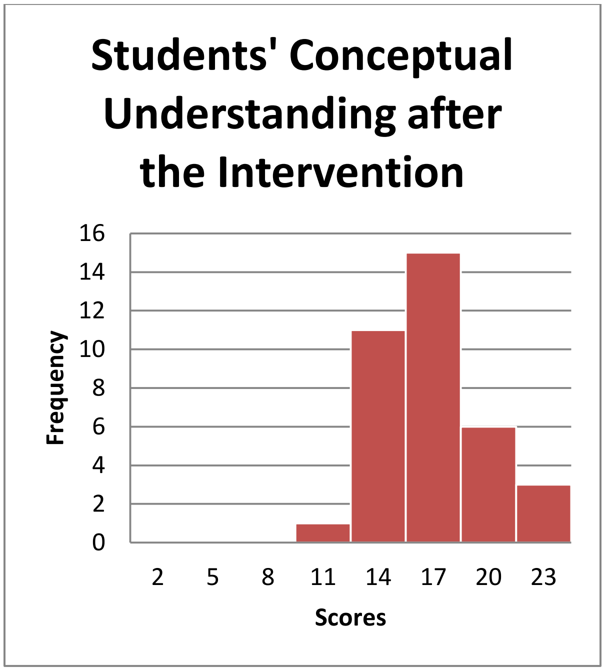


Fig. 6. Students' conceptual understanding after the activity-based teaching

On the other hand, Figure 7 is a histogram that is asymmetrical in shape. Most of the students (highest frequency) got scores either 7 or 8. There is no gap in the graph having a maximum data value of 16 and a minimum of 5. The graph also shows that the scores of students increased particularly the 31 students who passed the 16 - item test. Five students got a perfect score that appeared on the right tail end of the histogram. However, there were still 6 students who failed the test.

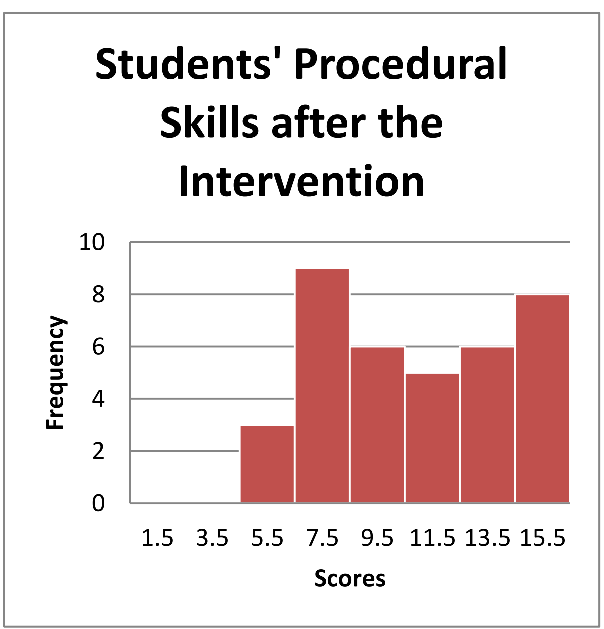
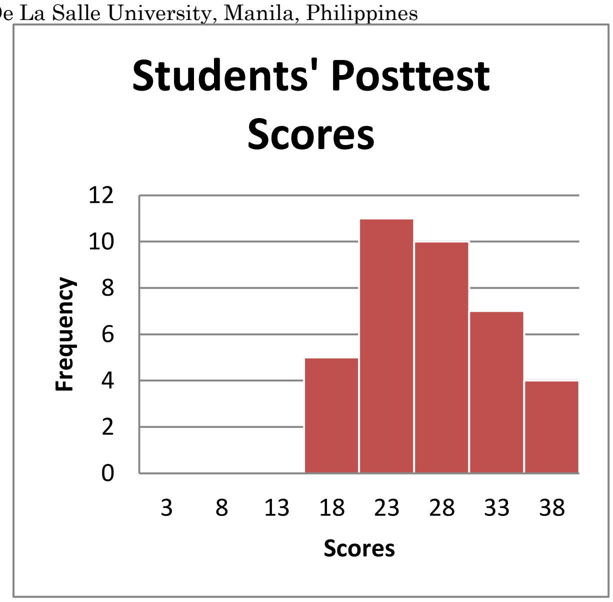


Fig. 7. Students' procedural skills after the activity-based teaching



In general, 40 items post-test results show that 36 out of 37 students passed the test which is equivalent to 97%. Only one failed. Based on Figure 8, the histogram is skewed to the right having a maximum value of 40 and a minimum value of 17. There is no gap or any extreme values. The mode or the peak of the graph falls under the score interval of 21 to 25 with 11 students located within this range where the passing score of 20 also lies. More than the majority of students got a score greater than the passing equivalent. As can be seen in the graph, 17 students fall on the score interval of 26 to 35 and there are 4 students who got scores within 36 to 40 interval. This only shows that students have increased their conceptual understanding and procedural skills after the activity-based teaching.

Fig. 8. Students' conceptual understanding and procedural skills after the activity-based teaching

Finally, a mean of 9.54 in the pre-test and a mean of 16.62 in the post-test based on the conceptual understanding items and a mean of 8.32 in the pre-test and a mean of 10.97 in the post-test of the procedural skill items showed evidence that students increased their level of understanding of concepts and procedural skills on integers.

3.3 Comparison between Prior and After the Activity-based Teaching

Based on the conceptual understanding items of the pre-test, only 14 students passed which is equivalent to 35% but the post-test results show that all students passed the conceptual understanding test. In procedural skills items, 18 out of 37 students passed the pre-test which is only 49% but 31 out of 37 students passed in the posttest which is equivalent now to 84%.

There are horizontal shifts in the graphs from the pretest scores to the post-test scores in Figures 9 and 10 towards the right indicating that every student improved and increased their scores. The two graphs indicating students' scores in their conceptual understanding test (Figure 9) are both positively skewed. However, the highest scores in the pretest and post-test are 19 and 24, respectively and the lowest scores in the pretest and post-test are 2 and 12, respectively. However, they have different peaks located at 11 and 17, respectively. Figure 10 shows how the students performed in the procedural skill test. There are more students who got the perfect score in the post-test than in the pretest. The lowest score of 3 in the pretest was improved to 5 in the post-test. The rising of the red graph towards the right provides a good indication that there is an increase in the number of students as it approaches the perfect score of 16.

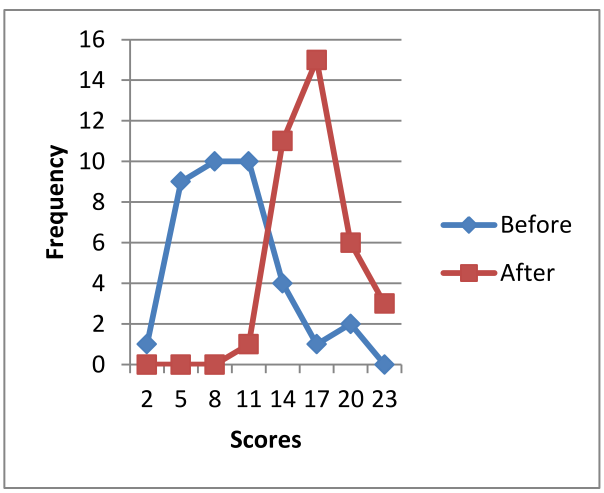


Fig. 9. Comparison between Students' Conceptual Understanding Scores before and after the Interventions

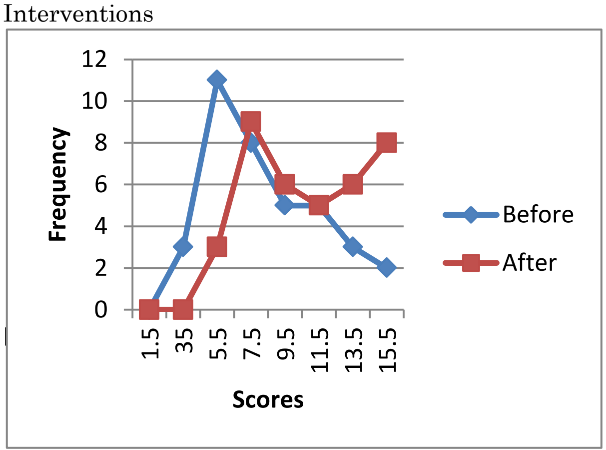


Fig. 10. Comparison between Students' Procedural Skills Scores before and after the Interventions

The overall result of the pre- and post-test as seen in Figure 11 shows that students had increased their scores as the red graph shifted towards the right of the blue graph. The blue graph indicates that there are more students in the lower scores and fewer students in the higher scores. The red graph shows otherwise. For example, in the blue graph 12 students have scores within 11-15 but the red graph indicates that there are no students who have scores lower than 11. On the other hand, from scores 21 and above, there are fewer students in the pretest and more students in the post-test. Noticeable of which is that none of the students got a score higher than 35 in the pretest. But there are 4 students who scored higher than 35 in the post-test. This progress indicates that there is a positive effect when activity-based teachings are integrated in the students' lesson on integers.

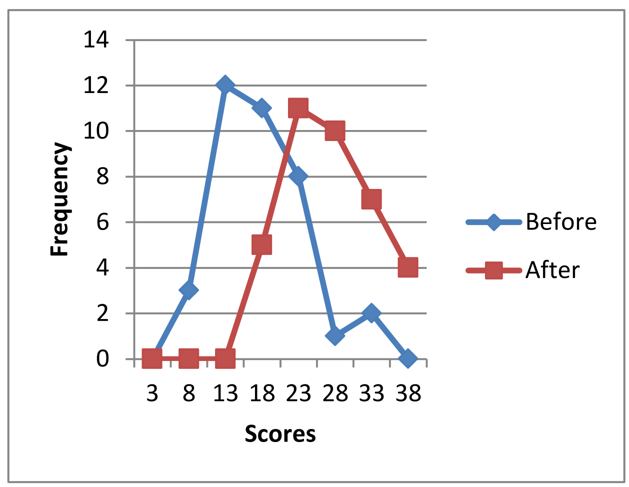


Fig. 11. Comparison between Students' Pretest and Post-test Scores

The researchers constructed the gain score table of students' conceptual understanding on integers (Table 1) and procedural skills (Table 2) to study the particular concept and operation the students find difficulty with and which misconceptions were corrected through the intervention. These gain score per item tables are based from the comparative frequency of correct responses graph of both the pre and post-test.

The individual student gain score calculation was adapted from the Teacher Work Sample Handbook of Black Hills State University College of Education, Emporia State University and the Renaissance Partnership for Improving Teacher Quality Project revised on August 2010. This computation is also parallel to the Hake gain formula called the Average Normalized Gain <g> or the Hake Factor h by Richard Hake (2001a). The researchers compared each student's pre-assessment result with its post-assessment result to determine improvement on specific concepts and procedural skills on integers after administering activity – based teaching.

Table 1. Gain Score Table on Conceptual Understanding (N=37)

CONCEPTUAL UNDERSTANDING						
Item	*Pre-test*		*Post-test*			
	# of students who passed	%	# of students who passed	%	GAIN	Average Gain per Concept
1	36	97	37	100	1	0.68
2	20	54	28	76	0.47	
3	13	35	22	59	0.38	
4	30	81	31	84	0.14	0.26
5	13	35	17	46	0.17	
6	20	54	28	76	0.47	
7	15	41	33	89	0.82	
8	23	62	35	95	0.86	
9	9	24	25	68	0.57	
10	21	57	31	84	0.63	0.60
11	14	38	27	73	0.57	
12	34	92	34	92	0	0.40
13	20	54	29	78	0.53	
14	31	84	35	95	0.67	
15	17	46	34	92	0.85	0.68
16	17	46	27	73	0.50	
17	4	11	17	46	0.39	0.42
18	13	35	27	73	0.58	
19	6	16	15	41	0.29	
20	5	14	10	27	0.16	0.31
21	4	11	13	35	0.27	
22	2	5	20	54	0.51	
23	5	14	15	41	0.31	
24	5	14	14	38	0.28	

Legend:
Number Line
Rules of Operations
Positive and Negative
Properties
Ordering of Integers
Comparing Integers
Essay

As can be seen in Table 1, the highest average gain of 0.68 is on concepts of number line and on how to model or represent positive and negative integers concretely like depositing and withdrawing an account. The lowest gain falls under the concept of the rules of operation which is only 0.26. This is where the students find it difficult to understand the rules in operations like subtracting a negative integer from a positive integer is the same as adding a positive integer to the opposite of the said negative integer, that the rules of signs in multiplication and division are the same and the idea subtracting integers may result to a positive integer. The computation of the class average gain score uses the percentage score of each individual student in their pre and post-test results. Once the individual students' gain score was computed using the gain score formula, the average gain score for the entire class as a whole was also obtained. This is done by taking the summation of the individual student's gain score divided by the total number of students who took the test. Therefore, in general, the whole class in Table 1 acquired a 0.48 average gain.

Table 2. Gain Score Table on Procedural Skills (N=37)

PROCEDURAL SKILLS						
Item	*Pre-test*		*Post-test*			
	# of students who passed	%	# of students who passed	%	GAIN	Average Gain per Operation
25	24	65	29	78	0.38	0.34
26	20	54	28	76	0.47	
27	18	49	21	57	0.16	
28	20	54	26	70	0.35	
29	10	27	19	51	0.33	0.40
30	14	38	29	78	0.65	
31	8	22	21	57	0.45	
32	14	38	18	49	0.17	
33	27	73	29	78	0.20	0.16
34	33	89	33	89	0	

35	16	43	22	59	0.29	
36	24	65	26	70	0.15	
37	17	46	25	68	0.40	0.36
38	22	59	26	70	0.27	
39	21	57	26	70	0.31	
40	20	54	28	76	0.47	

Legend:

- Addition of Integers
- Subtraction of Integers
- Multiplication of Integers
- Division of Integers

Based on Table 2, of the four operations in integers included in this study, students performed well on the post-test and corrected their misconceptions in subtraction of integers which garnered the highest average gain of 0.40. This only shows that the activity-based teachings particularly the integer chips model is effective with this operation. Nonetheless, multiplication of integers had a low average gain of 0.16. Generally, students' procedural skills obtained a group average gain of 0.32.

To have a clearer analysis, the researchers categorized the students' individual gain distribution based on Hake's gain classifications (1998a) in conceptual understanding and procedural skills separately. According to the author, the gain distribution can be divided into three regions which correspond to High-gain classification ($g \geq 0.7$), Medium-gain classification ($0.7 > g \geq 0.3$) and Low-gain classification ($g < 0.3$).

Using this gain categories, it was found out that under conceptual understanding test with 37 participants who took the test (refer to Table 3), 8 students (21.6%) belong to the low gain classification. More than two-thirds or 26 students (70.3%) belong to medium gain classification, 3 students (8.1%) are under high gain classification and one student got a 100% gain. The class average gain is equivalent to 0.45. The result shows that students increased their level of understanding on concepts of integers after the interventions were conducted.

In the over-all pre-test and post-test individual student gain score as shown in Table 3, it can be seen that each student obtained a positive gain after the interventions were applied. Nine (9) students (24.3%) have low gains, 23 students (62.6%) have medium gains and 5 students (13.5%) have high gains. In general, the result shows that activity-based teachings still help increased the students' conceptual understanding and procedural skills. This signifies that the participants were seriously learning the concepts and skills on integers and followed by student number 6 with 0.93 gain. The class average gain is 0.42 which falls under medium-gain classification ($0.7 > h \geq 0.3$).corrected their misconceptions after having exposed to activity-based teachings in their class as it appeared on the post interview result question number 7. Student number 27 acquired a 100% gain

Table 3. Students' Individual Gain Scores

Student	Pre-test score		Post-test score		Individual Gain
	score	%	score	%	
1	25	63	32	80	0.47
2	19	48	27	68	0.38
3	15	38	24	60	0.36
4	24	60	35	88	0.69
5	15	38	32	80	0.68
6	26	65	39	98	0.93
7	20	50	36	90	0.80
8	16	40	25	63	0.38
9	12	30	33	83	0.75
10	20	50	34	85	0.70
11	12	30	20	50	0.29
12	12	30	20	50	0.29
13	16	40	25	63	0.38
14	24	60	33	83	0.56
15	17	43	20	50	0.13
16	12	30	24	60	0.43
17	17	43	26	65	0.39
18	15	38	27	68	0.48
19	16	40	25	63	0.38
20	35	88	36	90	0.20
21	10	25	17	43	0.23
22	12	30	25	63	0.46
23	12	30	24	60	0.43
24	9	23	22	55	0.42
25	13	33	20	50	0.26
26	14	35	28	70	0.54
27	35	88	40	100	1.00
28	20	50	27	68	0.35
29	24	60	28	70	0.25
30	10	25	25	63	0.50
31	12	30	25	63	0.46
32	21	53	26	65	0.26
33	25	63	29	73	0.27

34	21	53	31	78	0.53
35	16	40	28	70	0.50
36	16	40	24	60	0.33
37	23	58	29	73	0.35
GROUP AVERAGE GAIN SCORE					0.45

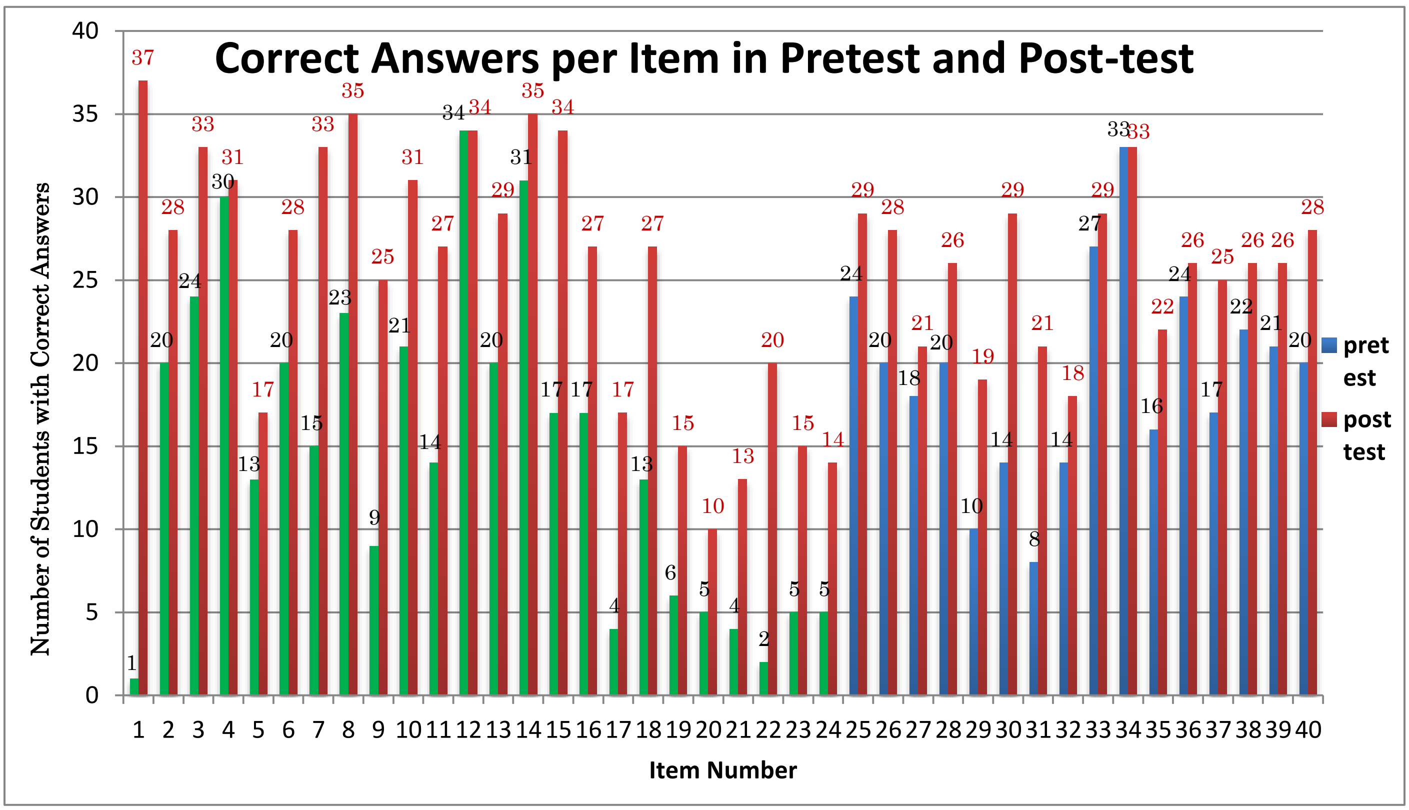


Fig. 12. Number of Correct Responses in Pretest and Post-test

The frequency distribution of correct answers per item in pre-test and post-test are shown in Figure 12. Based on the comparison of the results, it is evident that the class mean went up by 54.47%. Every student improved their scores; Post-test results show that 86% got a score above the passing rate, 11% belongs to the passing rate and 3% (equivalent to one student) did not pass. The mean percentage increase (64.8%) of the scores from the pre-test compared to the post-test showed significant progress on the application of activity-based teachings. Additionally, the improvement in some students was very significant. For example, in Table 3, all students had positive gained scores in their post-test. The group average gain score is 0.45.

Paired sample t test was used to compare the means obtained from the same group of samples at different times. The pre-test and post-test scores was compared to identify if there was a significant difference in the mean score of the test. The probability value obtained was almost 0 (i.e., 0.000) is less than the predetermined alpha value (a/2 = 0.025), thus the null hypothesis was rejected. This was supported also by the result of t calculated value -10.551 which is less than the t critical value of (-2.0281) and lies in the rejection level of the normal curve distribution. The findings suggest that when the pretest and post-test responses of the 37 participants were compared based on the overall score, there exists adequate evidence to show that the difference in the mean score of pre-test (17.86) and the mean score of post-test (27.59) was statistically significant. This conclusion was made at the significance level, a=.05 (5%) or confidence level (95%).

3.4 Students' Perception on the Activity-based Teaching

Based on the interviews with the ten students, all of them said that activities truly helped them understand the concepts of integers. Survey responses on question number 9 also showed that 70% of students preferred to have activities in teaching concepts and procedural skills because they felt excited and happy, they learned and at the same time they enjoyed. Half of them mastered the skills after the interventions were applied. When asked [What makes integers operations challenging?], 80% of students said that they are challenge in dealing with signs especially in subtraction of integers. When asked, how often they would like to use manipulatives in class, seven out of ten students suggested that activities should be in a daily basis as much as possible so they could understand the concepts, while three out of ten students suggested that activities should be incorporated when new topics are to be introduced. The same 80% of the students interviewed had difficulty in handling signs of integers particularly in subtraction of integers [What difficult experience have you had in performing operations of integers?]. This confirms previous related studies of Ryan & Williams (2007), Muñoz (2010) and Cunningham (2009) that students struggle with this foundational concept particularly around the use of negative numbers and mastering operations with signed numbers. Moreover, 3 out 10 students had difficulty when integers are incorporated in problem solving.

Students' answers to the survey questions that made use of Likert scale 1-4 (Strongly Agree – 4, Agree – 3, Disagree – 2, Strongly Disagree – 1) reveal that after the intervention, they no longer find integers difficult to learn. Most of them (70.3%of the students) disagreed to the statement [Integers are difficult things to learn and solve], on the other hand, 18.9% agree to this question. Seventy-three percent (73.0%) of students preferred to work in pairs or groups to learn integers rather than working alone. The survey responses showed that 35.1% of the students strongly enjoyed playing games in class, which allowed them to have the visual representation and have fun at the same time. All agreed that learning by doing is a useful tool for learning procedural skills in integers and concepts become interesting and fun when it is integrated with various activities. 54.1% appreciated integers because they find it useful in their lives as response. For statement number 10; [I don't think there is a need for me to explore integers' concepts]. I just memorize the rules], 26 out of 37 (70%) students disagree that in dealing with operations, they just memorize the rules while 11 students (30%) dwell on memorization. While memorizing algorithmic procedures may have a short-term advantage, understanding the process is necessary for the long-term development of sophisticated mathematical thinking. It's not bad to memorize steps and procedures, however, Ramaley & Zia, (2005); Young-Loveridge, (2005) emphasized that the true meaning of the ability to learn is not just to memorize the rules of a particular task, but to be able to discern what the rules should be, and to make sense from that input. Hiebertet. al. (1997) cited in Foster (2007), added by saying that, "when we memorize rules for moving symbols around on paper we may be learning something but we are not learning Mathematics" (p.164).

In general, the analysis of the survey showed that having an activity-based teaching promoted students' conceptual understanding and procedural skills and changes students' perception on integers into something positive and worthwhile.

4. CONCLUSIONS

That there is higher passing turn out rates in the given post-test compared to the pretest and that the difference is significant, all point toward effective use of various activity-based models in students' learning of integers. Students performed better in the post-test compared to the pre-test. Results also showed solid evidence that when students are engaged in activity-based teaching, a positive learning experience takes place and students achieve a better understanding of the concept. Thus, activity-based teaching introduced by the teacher can improve students' conceptual understanding, perception and procedural skills in integers. As revealed in their interviews, students like games and activities integrated in every math concept. These results are consistent with that of Muñoz (2010) showing the importance of the use of games and strategies in improving academic achievement in mathematics.

Students like to work in groups for sharing and collaborating of ideas. The use of activity-based teaching shape the way students think and build connections toward conceptual understanding thus fostering increase in student retention. Students eventually can extend their concepts of addition, subtraction, multiplication and division to positive and negative numbers.

At an early age of learning, pupils should be exposed in simple problem solving about integers. The concept of what is less and what is more, above zero and below zero temperature, savings and spending should be integrated on the first encounter of pupils on the concept of negative numbers for a deep and well-rooted conceptual understanding. The concepts about distances can enlighten them about absolute value that explains why absolute value is nonnegative. In addition, instructions must then be explicit particularly in solving operations of integers. That is, when a number has no preceding sign, the number is understood to be positive.

Language connections should be developed. Students' oral and written communication skills on the concepts of integers are equally important and should be given attention by letting students express the important concepts on operations of integers through group sharing, oral recitations, reflection notebook, essays and conceptual debates. It's not enough for students to solve any operation correctly; they must also have the skill to verbalize the concepts behind it and the skill to answer open-ended questions through written output.

Games and activities should be integrated in mathematics lessons to understand concepts and to master certain computational skills. With the integration of activity-based teaching into the mathematics classroom, more of the students will be able to experience the positive results indicated in this study. Teachers should be resourceful and creative to select models on how to teach certain concepts. Preparing, grading, and evaluating the activities can be time consuming, but may be worth pursuing if the teachers' aim is for students to learn. Environment rich in models which embody many facets of mathematical operations promotes student's ability to understand the mathematical concept of integers.

Furthermore, with careful planning, teachers can make mathematics come alive and make it more concrete and tangible for the learners. The result of this study may suggest teachers to design appropriate teaching strategies that will effectively deal with students' conceptual understanding and procedural skills on concepts and operations of integers. Discussions of rules in operations of integers are not enough but to expose students to various activities that will enhance their conceptions and skills on integers. If students have limited use of visual and hands-on representations, then it can be difficult to say whether they understand a mathematical idea or are just going through the motions without attending to meaning.

Mass training for teacher focusing more on the use of different teaching methods would likewise improve their teaching style to match with the learning style of the students for a better result of increasing their conceptual understanding and procedural skills on integers identified in this study. Mathematics should not be hated and feared by learners but to be enjoyed by doing some mathematical activities that foster understanding of concepts, mastering procedural skills, and develop oral communication and written skills as well.

6. REFERENCES

Borasi, R. (1990). The invisible hand operating on mathematics instruction: Students´ conceptions and expectations.In T. J. Cooney (Ed.), *Teaching and learning mathematics in the 1990s* (NCTM Yearbook), pp. 174-182. Reston: NCTM.

Brinkerkent, L. (2000). Connecting Integers to Meaningful Contexts.*Mathematic Teaching in theMiddle school,* 6(1), 62-66.

Burkhart, J. (2007).Integer target: Using a Game to Model Integer Addition and Subtraction.*Mathematic Teaching in the Middle school,*24(7), 388-392.

Cunningham, A. W. (2009). *Using the Number Line to Teach Signed Numbers for Remedial Community College Mathematics.*Mathematics Teaching-Research Journal On-Line,Bronx Colleges of the City University of New York, NY10451.

Downie, N.M., & Heath R. (1984).*Basic Statistical Methods.*Harper and Row Publishers, New York.

Fennema, E. & Franke, M. (1992).Teachers' knowledge and its impact in: D.A. Grouws (Ed)*Handbook of Research on Mathematics Teaching and Learning* (pp.147-516) New York, NY: Macmillan Publishing.

Flores, A. (2008). Subtraction of Positive and Negative Numbers: The difference and CompletionApproaches with Chip.*Mathematic Teaching in the Middle school,* 14(1), 21-25.

Foster, D. (2007). Making meaning in Algebra examining students" understandings and misconceptions.*Assessing Mathematical Proficiency.*53 , 163-176 Retrieved on January 22, 2008, from http://www.msri.org/communications/books/Book53/contents.html

Furner, J. M., Yahya, N., & Duffy, M. L. (2005).Teach mathematics: Strategies to reach all students.*Intervention in School and Clinic*, 41(1), 16-23.

Gluck (1991). Helping students understand place value. *Arithmetic Teacher*, 38 (7), 10-13.

Goracke, M. (2009).*The Role of Manipulatives in the Eighth Grade Mathematics Classroom.Action Research Projects.*Paper 71. Retrieved November 20, 2013 from http://digitalcommons.unl.edu/mathmidactionresearch/71

Hake, R.R. 2001a. "Suggestions for Administering and Reporting Pre/Post Diagnostic Tests", unpublished; online as ref. 14 at < http://physics.indiana.edu/~hake/ >.