

# Comparing the Effectiveness of Three Strategies in Teaching Selected Topics in Mathematics on the Students' Achievement in and Attitude toward Mathematics

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## Abstract

Three strategies in teaching Mathematics were implemented to First Year students of LPNHS-Main during the Third Grading Period S.Y. 2011-2012. A Quasi- Experimental Design was used to compare the effectiveness of the three strategies. The data were analyzed using independent and dependent sample t-test and ANCOVA to test the significant difference of means from the three groups. The results revealed that there is a significant difference in the pretest and post test mean scores in the achievement of each group, most remarkable in the group that was exposed to the manipulative materials. This shows that the use of Manipulative materials is the most effective strategy in terms of improving achievement of the student and it is followed by the Cooperative learning strategy while the Chalk-board and talk strategy is the least effective. Another key finding in this paper is that each of the three strategies has noteworthy weakness in at most one category in the attitude inventory. These are the students who were exposed in Chalk-board and talk strategy, had their personal confidence about Mathematics seemingly decreased. Similarly, those who undergone the Cooperative Learning strategy had their interest toward the usefulness of Mathematics apparently lessened and lastly, the group exposed in Manipulative materials appears to have their perception about the teacher's attitude in terms the care and concern with them also diminished.

## I. Introduction

Mathematics has its own rules and laws to be followed and memorized. It deals more on analytical thinking and problem solving. Students who do not have the fundamental foundation on basic mathematics will likely lead to poor mathematical ability.

Thus, taking this into account, Filipinos have never yet been noted for their mathematical aptitude as indicated from an international survey placing the country near the bottom; and similar local studies pointed out such low performance from students and teachers alike. (Nebres and Chua cited in Arespacochaga, 2011).

To further attest to this, when the Philippines participated in a comprehensive examination called Trends in Mathematics and Science Study (TIMSS) in 1995, which was intended to give information about the status of teaching and learning in Mathematics and Science, assessment showed that the

performance of the students in the Philippines was not good in terms of their cognitive level compared to our neighboring countries in Asia such as Singapore, Chinese Taipei, Hong Kong, Japan, and Republic of Korea.

The same unsatisfactory findings appeared again from TIMSS held last 2003, while some Asians consistently excel in their feats in mathematics globally, the Philippines, as dreadful as it could be remains behind ([nces.ed.gov/timss/](http://nces.ed.gov/timss/))

Similarly, the National Achievement Test (NAT) pointed out such low performance from students. Students, especially from lower sections, experienced difficulty in learning the basic concepts even if Mathematics teachers adapted various teaching strategies.

To contend with this problem, several studies were conducted on how to improve the students' achievement to somehow change their impressions and attitudes toward the

subject. After reviewing some of the strategies, the researcher found out that using manipulative material in teaching is less utilized.

Whereas, Mathematical manipulative are material objects from the real world that children move around to show a mathematical concept. They are concrete, hands-on models that appeal to the senses which can be touched by students. These materials could relate to the student's real world (Schweyer, 2000).

In connection to the different strategies, Understanding by Design as advocated by Grant Wiggins and Jay McTighe was introduced by DepEd in 2011 to facilitate the students in improving their achievement, McTighe and Seif in their research entitled "A Summary of Underlying Theory and Research Base for Understanding by Design", also revealed that the students who were exposed in authentic pedagogy were helped substantially whether they were high or low achieving students. The pedagogy also lessened the inequality of high-and low-performance in terms of their academic accomplishments.

Another commonly used technique employed by the teachers in teaching was the Traditional approach known as Chalk-board and talk strategy wherein the teacher controls the learning environment while rote learning occurred from the students in the mastery of their lessons.

Considering these strategies, however, most of the teachers encountered by the researcher when asked about the approach in teaching mathematics agreed that the Traditional approach is more effective than the Cooperative Learning or Understanding by Design approach. In cognizance, no comprehensive studies were found in the location regarding the effectiveness of the use of Manipulatives compared to Cooperative learning as well as the Chalk-board and talk.

In view of this, the researcher would like to carry out a research to determine which among the strategies is effective. The researcher also saw the need to revolutionize the methods in teaching especially for the subject that seemed to be non-favorite by most students, taking into account that the perception and attitude on mathematics

should proportionate to how students perform on the lesson in the same nature.

## **II. Methods**

The study used Quasi- Experimental design to compare the effectiveness of the three strategies. Achievements in Mathematics and attitude inventory were administered to the three classes before and after the treatment.

The data gathered were analyzed by using Descriptive statistics, independent and paired sample T test, and Analysis of Covariance. The respondents of this study involved three middle sections from First Year high school students in Las Pinas National High School - Main (Philippines), during their Third Grading period in the school year 2011-2012. These sections were assigned as the Traditional group, UBD group, and Manipulative group. The researcher handled the three groups to avoid the teacher factor effect on the students' achievement and attitude in Math.

In Group 1, the traditional group, the teacher applied the Chalk-board and talk strategy. Group 2, the Understanding by Design (UBD) group, exposed to the Cooperative learning strategy while Group 3, the Manipulative group, used algebra tiles as the manipulative materials. Achievements in Mathematics and attitude inventory were administered to the three classes before and after the treatment.

The researcher did not change the regular classroom situation schedule of each class, but for the purpose of analysis, only the students with complete data in pretest and posttest in Mathematics achievement and attitude scale were considered.

The researcher used two instruments such as achievement in Mathematics and attitude inventory. Achievement in Mathematics was a teacher- made test which was validated by six evaluators who have been teaching Mathematics for more than ten years and have units in Master of arts major in Mathematics. To determine the attitude of the students in each group Modiin A, ed Fennema- Sherman Mathematics Attitude Scale which was prepared by participating teachers in the Leadership Program for Teachers (LPT) of the Woodrow Wilson National Fellowship Foundation was used.

The Attitude scale inventory were divided into three categories namely; personal confidence about Mathematics (P), usefulness of Mathematics(U), and perception of the teachers' attitude (T).

### III. Results

#### Part I: Achievement in Mathematics

This part describes the results of the achievement test in Mathematics of each group before and after the experiment.

**Table 1:** Descriptive Statistics for the Achievement in Mathematics of the Three Groups

Pretest		Posttest			
Groups	n	Mean	sd	mean	s
Traditional	21	8.81	3.11	12.62	
UBD	26	11.12	2.36	15.31	
Manipulative	20	9.65	3.28	14.75	

It can be figured out from the table that the UBD group has the highest pretest and posttest mean scores, followed by the Manipulative group and the Traditional group. Respective values of the standard deviation revealed that the scores of the respondents from the UBD group are closer to each other compared to those in the Traditional and Manipulative groups. Respective values of pretest mean score of each group resulted to low achievement in Mathematics. As regards to the computed standard deviation, the scores of the respondents from UBD group are closer to each other compared to those in Traditional and Manipulative.

**Table 2:** Comparison of Pretest Mean Achievement in Mathematics of the Paired Groups

Paired Group	t-value	p-value	Remarks
UBD and Trad	2.894	0.006	S
Man and Trad	0.842	0.405	NS
Man and UBD	-1.690	0.100	NS

S: Significant NS: Not Significant

The t-test for independent samples was applied to test if any significant difference exists between the pretest mean scores of paired groups. Based on the computed p-values shown in Table 2, there exists a significant difference between the pretest mean scores of the UBD and the Traditional groups at the .05 level of significance. This indicates that these groups were not comparable at the start of the experiment so that ANCOVA was used to make sure that whatever mean scores the groups will have after the experiment were solely due to the treatment.

On the other hand, no significant difference exists between the Manipulative and the Traditional groups as well as between the Manipulative and the UBD groups. This shows the comparability of these two groups at the 4.63start of the experiment.

Source	Sum of Squares	p-value
Corrected Model	308.653*	0.000
Intercept	95.815	0.013
Pretest	308.653	0.000
Error	641.815	
Total	10303	
Corrected Total	950.468	

\*R Squared = .325 (Adjusted R Squared = .310)

Table 3 shows the result of the ANCOVA applied to the pretest mean scores of the UBD and the Traditional groups.

**Table 4:** Comparison of the Pretest and Posttest Mean Achievements of the Three Groups

Mean Scores			
Group	Pre	Post	P-value
Traditional	8.81	12.62	0.000
UB	11.12	15.31	0.000
Manipulative	9.65	14.75	0.000

\*Significant if  $< 0.05$

Apparently, the Manipulative group registered the highest mean gain as seen in the table. This indicates that learning took place using all the teaching strategy understudy. This finding confirms the findings of the studies conducted by Calosing (2011), David and Vicente (2011), Brown (2007), Allen (2007), and Apat Sr. (2006). Yet, this finding contradicts the study found from 2001 and beyond. These are the works of Taylor (2001, cited in Brown, 2007), Lester Jr. (2007), who cited the works work of Filloy and Rojano (1989), Boulton- Lewis et al (1997) and Sharp in 1995.

**Table 5:** Comparison Between the Posttest Mean Achievements of the Paired Groups

Paired Groups	t-value	p-value	Remarks
UBD and Trad	2.088	0.042	S
Man and Trad	1.405	0.168	N
Man and UBD	-4.408	0.685	N

S:Significant N:Not Significant

#### Part II: Attitude toward Mathematics

This part deals with the attitude toward Mathematics of each group of respondents before and after the experiment.

**Table 6:** Descriptive Statistics for the Attitude toward mathematics of the Three Groups

\*Frist value is the pretest mean score while the second value is the posttest mean score.

Groups	Confidence	Usefulness	Attitude
Tradition al	3.54; 3.23	3.13; 3.01	3.61; 3.48
UBD	3.72; 3.64	3.03; 2.86	3.50; 3.41
Manipulative	3.59; 3.68	3.20; 3.20	3.75; 3.39

The t- test for independent samples was utilized to compare the posttest mean achievement of the paired groups. Based on the computed p-values shown in the table, it can be said that significant difference exists between the posttest mean achievement of the UBD and the Traditional groups in favor of the UBD group. However, the Manipulative and the Traditional groups as well as the Manipulative and the UBD groups did not register any significant difference in their posttest mean achievement. This indicates that these two paired groups are almost equally effective in teaching the Algebraic Expressions, Special Products and Factors, and Factoring Polynomials.

A comprehensive study of the table above reveals that the pretest and posttest mean scores of the respondents' personal confidence about Mathematics of each group is interpreted as agree. This leads to the respondents' feeling that they can learn Mathematics. Comparing the pretest mean scores of each group, UBD has the highest followed by the groups of Manipulative and Traditional. This indicates that the respondents in UBD group are more confident about Mathematics based on the groups' data before the treatment. On the other hand, the group exposed in manipulative materials gained the highest mean score after the treatment as compared to the other groups.

As regard to the respondents' thinking about the usefulness of Mathematics, the pretest and posttest mean scores of each group is interpreted as not sure. This implies that the respondents exposed in each strategy were not convinced about the importance of

Mathematics in their lives. However, Manipulative group's pretest and post test scores stood out among the three groups. In terms of the students' pretest and posttest in teacher's attitude, their mean scores were interpreted as not sure. This signifies that the respondents were not sure about the feeling of the teacher towards them. Analyzing the pretest mean scores of each group, the Manipulative group has the most optimistic thoughts compared to the other groups. However, posttest mean shows that the Traditional group's thought about the perception of the teacher's attitude is more optimistic, while the Manipulative group resulted to unenthusiastic feedback among the three groups. The standard deviations of the pretest and posttest indicate a close approximation among the respondents in so far as attitude toward Mathematics is concerned.

**Table 7:** Comparison of the Pretest Attitude Scores of the Paired Groups

Paired Groups	C	U	A
UBD and Traditional	N	N	N
Manipulative and Traditional	N	N	N
Manipulative and UBD	N	N	N

C: Confidence U: Usefulness T: Teacher's Attitude

Table 7 shows that the three paired groups are nearly equal in terms of their confidence and perception about the usefulness of Mathematics as well of their perception on the teacher's attitude.

**Table 8:** Comparison of the Pretest and Posttest Mean Attitud Scores of the Three Groups

Groups	C	U	A
Traditional	S	N	N
UBD	N	S	N
Manipulative	N	N	S

S: Significant N: Not Significant

In Table 8, each strategy resulted to lower mean score in most of the attitude categories in the pretest and posttest attitude inventory. The respondents in Traditional group have

lower personal confidence about Mathematics after the treatment denoting that Chalk-board and talk strategy made them less confident in Mathematics. This may be so because the students were already fed up with the usual technique that they encountered in their every day class discussions. Also, UBD group showed no significant difference. This signifies that the cooperative learning does not affect their personal confidence about Mathematics. In addition, the Manipulative group slightly increased their mean score but still, it does not totally affect on the respondents' personal confidence about Mathematics.

In terms of the usefulness of Mathematics, in the UBD group, there is a significant difference in their perception about it as the attitude mean score decreased after the treatment. This entails that the students who were exposed in cooperative learning or activities in groupings lessen their views about the usefulness of Mathematics. There could also be a possibility that the students in this group did not participate from the said activity for the reason that either they do not like their group mates or they just allowed their classmates to do the activity for them. In contrast, Traditional group denotes no significant difference exist between their pretest and posttest attitude scale. This leads to the students who were exposed in Chalk-board and talk which has no effect on the perception about the usefulness of Mathematics. In the same way, Manipulative group's pretest and posttest mean score did not incur changes which resulted to no significant difference. This signifies that the use of manipulative does not have an influence on the students' belief about the usefulness of Mathematics after the experiment.

In terms of students' sensitivity to teacher's attitude, Manipulative group's p-value resulted to no significant difference between their pretest and posttest. Furthermore, this group had a decreased perception about the teacher's attitude after the treatment. The researcher's inference on this could be due to teacher's lack of personal concern to students while teaching since they gave more attention in manipulating the algebra tiles. Meanwhile, Traditional and UBD groups resulted to no

significant difference between their pretest and posttest. This implies that the two strategies do not affect the students' perception about the teacher's attitude.

Herein, the use of manipulative was not significantly related to the students' attitudes in terms of their personal confidence and usefulness of Mathematics. Thus, this finding confirms the study conducted by the Filipino researcher named Jumalon (2009) that the use of manipulative was not related to the students' attitudes toward Mathematics. Considering that Filipinos are well known for being flexible, in this manner, by nature they have the talent to adapt in their environment. In associating this, the student easily became accustomed in classroom setting exposed in manipulative material. This further verifies that the use of manipulative, specifically the algebra tiles, do not affect the students' attitude in terms of their personal confidence and usefulness of Mathematics.

On the contrary, this study contradicts the findings found by Brown (2007) in Michigan, USA that the students have favorable attitude about the use of concrete manipulative. This is so because the experimentation of this study was conducted only in two days due to respondents' school curriculum. Hence, further investigation was limited to justify his findings in relation to respondents' reaction toward the concrete manipulative.

**Table 9:** Comparison of the Posttest Attitude Scores of the Paired Groups

Paired Groups	C	U	A
UBD and Traditional	S	S	N
Manipulative and Traditional	S	N	N
Manipulative and UBD	N	S	N

S: Significant N: Not Significant

The above table shows the comparison among the posttest attitude scores of paired groups UBD and Traditional, Manipulative and Traditional, then Manipulative and UBD. In terms of their p-values, as reflected in their personal confidence in Mathematics, the UBD and Traditional groups have significant difference. The UBD group appears to be more confident than the Traditional group.

The paired groups Manipulative and Traditional have significant difference. Wherein, the Manipulative group are more confident in Mathematics compared to the Traditional group. Emerging to have no significant difference at all is the paired groups Manipulative and UBD.

Going to the aspect of the students' perspective in the usefulness of Mathematics for them, the UBD group has less positive feelings toward it compared to the Traditional group resulting to significant difference between the two groups. While referring to that, the Manipulative and Traditional groups resulted in no significant difference; the Manipulative group has positive outlook rather than the UBD group.

With respect to the students' perception of teacher's attitude, there is no significant difference among the three paired groups. This concluded that the three paired groups were approximately having the same point of view after the treatment as perception to teacher's attitude is concerned.

#### IV. Discussion

##### I. Achievement in Mathematics

The mean achievement scores in Mathematics before and after the treatment were consistent in their ranking with the UBD group, getting the highest score among the three groups. This was followed by Manipulative and the Traditional group with the least mean score.

Significant differences in the mean achievement scores exist among the three groups after the treatment with the Manipulative group registering the highest mean gain. As regard to paired groups, no significant differences existed in the paired groups Manipulative and Traditional, and Manipulative and UBD while significant difference existed in the paired groups UBD and Traditional. This was corrected by the ANOVA and resulted to the similar findings. After the treatment, significant differences between the said groups also existed while there is no significant difference on the paired groups Manipulative and Traditional, and Manipulative and UBD.

## II. Attitude toward Mathematics

As regards to the attitude toward Mathematics, the UBD group had the highest personal confidence in mathematics before the experiment and turned to the Manipulative group after the experiment. In terms of usefulness in mathematics, the Manipulative group had the highest pretest and posttest mean scores. Manipulative group also had the highest mean score during pretest and turned to Traditional group in the posttest as attitude of teacher toward them is concerned. The respondents' posttest mean scores of each group revealed that each strategy had its weak points on each category of attitude. The Traditional group decreased their personal confidence in Mathematics, UBD group lessened the usefulness of Mathematics and Manipulative group diminished their perception about the teacher's attitude toward them.

With regards to the three attitude categories, the mean scores before the treatment resulted to no significant difference among the paired groups. However, under the posttest mean scores in the category of students' personal confidence, significant difference existed in the paired groups UBD and Traditional, and Manipulative and Traditional while no significant difference exist in the paired groups Manipulative and UBD. In terms of usefulness of Mathematics the posttest mean scores of the paired groups UBD and Traditional, and Manipulative and UBD resulted to significant difference while no significant difference existed in the paired groups Manipulative and Traditional. On the attitude category about the students' perception on their teacher's attitude toward them, no significant difference existed in each paired groups.

Based on the findings, the following conclusions were drawn: The use of Manipulative materials, specifically the algebra tiles, is the most effective in improving the achievement of the students followed by Cooperative learning strategy with Chalk-board and talk strategy as the least effective. On the other hand, none of the groups indicated a favourable change in attitude as seen from each category from Attitude Inventory. In relation to that, each strategy had its visible weakness on each

category of attitude. Students exposed in Chalk-board and talk strategy decreased their personal confidence about Mathematics. The respondents exposed in Cooperative learning or by working in a group lessen their interest toward the usefulness of Mathematics and the students exposed in the Manipulative materials decreased their perception about the teacher's attitude in terms of their care and concern with the students.

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