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MATH FACT FLUENCY: ACHIEVING MASTERY LEARNING IN MATHEMATICS THROUGH VARIOUS MODALITIES

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Abstract

The study was conducted to determine how various modalities of math fact fluency such as contest-type game, taped problems, timed drill practice and traditional approach improve students' mastery learning in mathematics particularly in the operation of polynomials. Specifically, it described the mastery learning of the students before and after the implementation of the various modalities of math fact fluency. Also, it identified if there are significant differences in the mastery learning of the students based on the pre-test and post-test results of the four learning groups. Moreover, it aims to recognize how did the modality help improve the mastery learning of the students.

The study adopted the mixed methods of research and utilized the quasi-experimental method of study, specifically, non-equivalent pre-test – post-test design. The researcher involved 80 respondents in this study that were chosen from the four out of 13 sections of Grade 7 students. This was conducted from February 13 to March 28, 2017, at Obando National High School during the school year 2016 – 2017.

The instruments used to gather data were the: (1) Test of Mastery Learning consisted of forty (40) items multiple choice type of exam; (2) IRF Worksheet used to describe the level of mastery of the topic discussed with the modalities of math fact fluency; and (3) Situation, Task, Action, and Results (STAR) Observation Technique to assure the proper implementation of the experiment.

The data of the study were treated using descriptive and inferential statistics. Mean and mean percentages were used to describe the mastery learning of the students before and after the treatment. The t-test was used to identify the significant difference between the pre-test and post-test of each

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strategy. Analysis of Variance (ANOVA) and Post-Hoc ANOVA using Tukey Test were also used to statistically analyze the results of the pre-test and post-test of the respondents exposed to the different teaching strategies.

The results of the study showed that the various modalities have significant impact on the mastery learning of the students. There are significant differences between the pre-test and post-test results of the learning groups which proved that either of the various modalities was employed; there was a significant improvement in the mastery learning of the students. Furthermore, contest-type was revealed be the most effective modalities since there are significant differences in the mastery learning of the students in the four strategies of teaching based on the post-test results.

In light of the findings of the study, the researcher recommends utilizing math fact fluency modalities as the alternative or supplemental strategies in teaching operations on polynomials as well as other topics involving the four fundamental operations. Further study that would analyze math fact fluency modalities on students' mastery learning can be conducted using other modalities that may help students further deepen their understanding on mathematics subject and make them fluent in math facts.

Introduction

In the Philippine education system, mastery of the subject matter is the top priority of all educators. To produce students who have high-level understanding and facility in requisite of key goals were part of it. To achieve this goal, the Department of Education (DepEd) created an organized curriculum content with distinct set of advanced skills and processes. They implemented the K to 12 basic education curriculum that envisions the students to possess sufficient mastery of basic competencies and skills in problem solving, creative and critical thinking. The mathematics curriculum is in spiral progression approach to provide opportunities for learners to deal with content develop mentally and serves as an aid to the process of discovery learning. Ideas may be built upon and associated to previous learning throughout the curriculum as students become more proficient and experienced in mathematics.

However, the mathematics classroom performance of the students seems to contradict the objectives of the program. Students were being promoted to next year level without the satisfying knowledge of the previous year.

Aside from that, DepEd reported that the National Achievement Test (NAT) mean percentage score for high school in the school year 2012-2013 was 51.41% and specifically 46.83% in Mathematics. Moreover, the Philippines ranked 67th of 140 countries in the quality of math and science education in the 2015-2016 Global Competitiveness Report of the World Economic Forum and 79th of 138 in the 2016 – 2017 data (Dela Cruz, 2017).

The low rank and MPS unveil that the mastery level of students in the subject is not even satisfactory and many students struggle with mathematics.

The barrier in achieving an outstanding mastery level is affected by different factors. One of these is the students' low retention rate. The students fail to store and retrieve information and skills taught to them. In a mathematics class, the students can answer an activity on a certain day but then the next day, they

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were not able to neither repeat nor recall the same operation. Having low retention may indicate that the students were not able to master certain facts in mathematics. Thus, this mean those students failed to develop fluency.

This situation shows that once these students leave the classroom, they also leave behind the concepts and skills taught to them. When presented a math problem, they are not good at executing previously taught strategies nor activate prior knowledge to solve the problem. They can perform well during discussions but get low scores on examinations. If the test was presented the other day, students can be overheard thinking aloud saying things like “How is it again?”, “Am I doing this right?” or “I cannot remember the process.” These dilemmas are proof that they already forgot the skill. The teacher then re-teaches the competency only to have the same attainment repeated over a new topic.

The reason why students were not able to retrieve certain facts because of the numerous lessons discussed to them without being able to master the basic facts. Another scenario is that during elementary days, students were taught on how to perform basic operations, but due to lack of time and still many lessons are waiting, the teachers will just advance to the next lesson even if the students are not good enough on a certain operation. Aside from that, the number of school days is not enough to discuss all the competencies needed for a certain grade level; suspension of classes, school activities and holidays were some of the cause of delay in classroom discussion.

Another factor that may be attributed to poor mastery of students in mathematics is the teaching competence possess by the teachers and their skills in utilizing the methods and strategies in teaching their lessons. The quality of learning is related to the quality of teaching done by the teacher. The teacher who lacks the necessary skills in a concept could not able to impart to his/her students the ability to perform mathematical operations. Aside from that, the teachers could not be competent enough if the teaching and learning materials needed are not sufficient. Thus, lead the students to difficulty in comprehending with the mathematical problems given to them.

One solution to solve these issues is that the students should be able to develop the ability to recall math facts fluently. Learners who acquire fluency can recall facts and comprehend with the concepts of addition, subtraction, multiplication and division. They can also use them when necessary in identifying the answers to math problems such as counting strategies and number line. When students achieved fluency with math facts, these concepts are retained over time and can be applied to higher-level tasks.

The capability to quickly recall math facts lessens students’ anxiety when it comes to completing more advanced tasks because they require less effort and time to accomplish the skill resulting in a richer schedule of reinforcement. It also increases their confidence to engage in more challenging math tasks. Engagement in these tough tasks is expected to lead to improved skill development. Additionally, students who are fluent in their facts are more likely to have more opportunities to respond and can now easily master the subjects upon being fluent on basic facts.

On the other hand, students who failed to attain fluency may, in turn, struggle with more complex math skills. Without the mastery of basic skills, students are left with inconsistent skill to develop strong math skills and learned ineffective retrieval strategies. This lack of proficiency can contribute to students’ inability to precede both academically and vocationally. In turn, this can lead to poor school performance and low national achievement test results.

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Guided by the foregoing discussions, the researcher felt the need of implementing math interventions to improve math skills. Teachers, therefore, should use more innovative interventions that are oriented toward active learning, thereby boosting more of students' inclination to discover new ideas. There are many interventions available to help students develop fluency. Teachers can use flashcards, games, raps, songs, timed tests or worksheet drills to support students with accuracy and recall of basic math facts. Aside from that, interventions that contain the components of practice with modeling and drill result produced the largest treatment effects as investigated by Coding, Burns and Lukito (2011).

In light of this concern, this study conducted the various modalities of math fact fluency such as contest-type game, taped problems, timed drill practice, and traditional approach to achieve the mastery learning of the students in mathematics. As well as introducing strategies that will replace the use of fingers and flashcards with innovative technology, individualized instruction, and enticing practice opportunities to lead students from procedural information to declarative knowledge of critical math facts.

Statement of the Problem

The general problem of the study was: "How do various modalities using math fact fluency improve students' mastery learning in mathematics?"

Specifically, the study sought answers to the following questions:

1. How may the mathematical performance of the four learning groups be described before the implementation of the various math fact fluency modalities?

2. Are there significant differences in the pre-test results of the learning groups?

3. How may the mastery learning of the students exposed to the following math fact fluency modalities be described based on

contest-type

timed drill practice

taped problems, and

traditional approach?

4. Are there significant differences in the mastery learning of the students based on the post-test results in the four strategies of teaching?

5. Are there significant differences between the pre-test and post-test results of the learning groups?

6. In what way did each modality help improved the mastery learning of the students in the group?

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Methods

The study adopted the mixed methods of research, a combination of qualitative and quantitative methods of research. According to Creswell and Clark as cited in Cameron (2014), mixed methods research is a research design with theoretical guess as well as methods of inquiry that guide the direction of the collection and analysis of data. Its fundamental principle is that the use of quantitative and qualitative approaches in combination provides a better understanding of research problems that either approach alone.

This study utilized the quantitative research in determining the students' mastery learning in operations on polynomials by means of the pre-test and post-test of the four groups of respondents. According to Babbie (2010), quantitative methods emphasize objective measurements, focuses on gathering numerical data and generalize it through groups of people or to explain a particular experience. The type of quantitative research utilized is the quasi-experimental method of study. Quasi-experimental design is an empirical study used to approximate the effect of an intervention on its target population without random assignment. According to Fraenkel and Warren as cited in Mendoza (2011), this design is most appropriate in investigating the effectiveness of an intervention with the availability of intact groups.

Specifically, this study used the non-equivalent pre-test – post-test design which had been described as one of the most commonly used quasi-experimental designs in educational research (Cohen, Manion & Morrison, 2007). This is often the case since students are naturally organized in groups as classes within schools and are considered to share similar characteristics. In this design, the four learning groups completed a pre-test and post-test. Groups are considered non-equivalent as groups are not randomized.

Since this research aimed to gather an in-depth understanding of the effect of the math fact fluency modalities on students' mastery learning in mathematics, using quantitative research approach is not enough. Thus, qualitative research was also applied to substantiate the quantitative findings.

According to Wyse (2011), qualitative research is primarily exploratory research. It provides insights into the problem or helps to develop ideas or hypotheses for potential quantitative research. In a qualitative research, respondents give their opinions based on what they have experienced that will support the results of the quantitative data gathered. Detailed data is gathered through open ended questions that provide direct quotations.

Since qualitative researches result in words as data for analysis, the qualitative part of this study was done through reading, analyzing and interpreting students' written responses on Initial-Revised-Final (IRF) worksheet. The result from this supported the outcome of the test of mastery learning by explaining how and why each group obtains their respective levels on each topic. Moreover, this approach was utilized to determine the outcome of this study through analyzing the STAR observation filled by the teacher observers.

Population and Sample of the Study

The respondents of this study were chosen from the 13 sections of Grade 7 students of Obando National High School on the school year 2016 – 2017. Through the use of cluster sampling, the respondents of the study were identified. The third quarter grades of the students in a section were matched to the other

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sections. Out of 13 sections, four sections; twenty (20) students in each section were chosen as the sample of the study. These were sections Magnolia, Jasmin, Sunflower and Orchids.

The study was conducted from February 13 to March 28, 2017, covering a total of 24 sessions with an hour per session, excluding the time used for the pre-test, post-test and answering Initial-Revised-Final (IRF) worksheets. To attest that classes were held in relation to study, the mathematics coordinator and an experienced mathematics teacher were invited to observe each class. They were given furnished copies of lesson plans (see Appendix I), as guide on the onset of the lesson proper and observation instruments during the implementation of this study.

Research Instruments

The researcher used the following instruments to collect the data needed for the study:

Test of Mastery Learning. The test of mastery learning (see Appendix B) used in this study were the pre-test and post-test. They were teacher made test consisting of 60-item multiple choice type of questions constructed by the researcher and subjected to item analysis. For the validity of the test, it was administered to Grade 8-Aguinaldo of Obando National High School. This grade level was chosen since the Grade seven students had no prior knowledge on the operation of polynomials yet before the administration of the study. The difficulty index and item discrimination were computed and items with negative values were discarded. Ten poor items were revised whereas the other poor items were discarded. For the final form of the test, 40 questions were left that covers the operations on polynomials (addition, subtraction, multiplication, and division) as reflected in the table of specification (see Appendix C). The test was also presented to researcher's thesis adviser, critic and three (3) experienced secondary mathematics teachers of ONHS for face validation. It was used to determine if there is a significant gain in the mastery learning of the students in each topic that was discussed using the various modalities of math fact fluency.

Initial Answer – Revised Answer – Final Answer (IRF) Worksheet. To describe the level of mastery of the topic discussed with the modalities of math fact fluency, the IRF worksheet (see Appendix D) was used. This was done through answering the topical questions before, during and after the lesson. The responses of the students in the IRF worksheet were described using the constructed criteria (see Appendix E). It was developed by the researcher and presented to the adviser and critic for suggestions and approval.

STAR Observation Technique. A Department of Education (DepEd) supervisory tool, Situation, Task, Action, and Results (STAR) observation form, was used to narrate observers' observation about the four aspects of the teaching-learning process. The supervisory tool is composed of four parts: (1) Situation. It focuses closely the context and teaching episode, (2) Task. It focuses closely the teacher's actions in the particular situation described, (3) Action. It used to describe the learners actions relative to the teacher's task, and (4) Results. It focuses and observes the end result or outcomes of the teacher's task and the learner's action.

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Results and Discussion

Part I. The Mastery Learning of the Four Learning Groups Before the Implementation of the Various Math Fact Fluency Modalities

In describing the mastery learning of the four learning groups before the implementation of the treatment quantitatively, a pre-test was administered. It was used to predetermine the level of mastery based on the mean results of the test. The K to 12 levels of proficiency was used as the basis for situating each group's level of mastery in the operations on polynomials. Table 1 shows the mastery learning of the respondents before the application of the four teaching strategies based on pre-test results.

Table 1

Pre-test Mean Results of the Four Learning Groups before the Treatment

Various Modalities	Pre-test Mean	Level of Mastery
Contest-type (CT)	13.3	Beginning
Timed drill practice (TDP)	12.55	Beginning
Taped problems (TP)	13	Beginning
Traditional Approach (TA)	12.35	Beginning

The entries in Table 1 indicate the mean results and level of mastery of the four learning groups before the experiment. As can be gleaned in the table, the mean results of the pre-test scores of the respondents in contest-type were 13.3, timed drill practice was 12.55, the taped problem was 13 and traditional approach was 12.35. It can be seen also that the respondents in the four learning groups categorized in *beginning* level. It implies that the respondents have no prior knowledge about the operations on polynomials. It was supported by the responses of the students in the IRF Worksheet, Initial Portion, wherein students does not mention any of the required concepts in his/her explanations and provides incorrect answers (see Appendix F for sample IRF responses).

Part II. Significant Gain in the Mastery Learning Based on the Pre-test results of the learning groups

This section presents the comparison of the results of the four learning groups using Analysis of Variance (ANOVA). From this, the researcher tested the hypothesis if there are significant differences in the mastery learning of the four learning groups based on the pre-test result in Table 2.

Table 2

Summary of Significant Gain in the Mastery Learning Based on the Pre-test results of the four learning groups

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Source of Variation	SS	df	MS	F stat	P-value	F critical	Interpretation
Between groups	14.0375	3	4.679167	0.570401	0.636206	2.724944	
Within groups	623.45	76	8.203289				Not Significant
Total	637.4875	79					

Evidently, the results of the pre-test scores of the four learning groups have no significant difference since the P-value of 0.636206 is greater than the set level of significance of 0.05 while the F computed value of 0.570401 is less than the F critical value of 2.724944. This indicates that the mastery learning of the four groups was at the same level of proficiency before being exposed to the modalities.

Part III. The Mastery Learning of the Students Exposed to the Various Math Fact Fluency Modalities

Post-test was administered in describing the mastery learning of the students exposed to the various modalities of using math fact fluency quantitatively. The results of the test predetermined the level of mastery. The K to 12 levels of proficiency was used as the basis for situating each group's level of mastery in the operations on polynomials. These were supported by qualitative discussion of the students' responses on IRF worksheets. Table 3 shows mastery learning of the subjects exposed to the four teaching strategies based on post-test results.

Table 3

Post-test Mean Results of the Students Exposed to the Four Modalities of Math Fact Fluency

Various Modalities	Post-test Mean	Level of Mastery
Contest-type (CT)	31.85	Approaching Proficiency
Timed Drill Practice (TDP)	30.60	Developing
Taped problems (TP)	28.15	Beginning
Traditional Approach (TA)	27.25	Beginning

The entries in Table 3 indicate the results of the post-test and the level of mastery of the four learning groups after the experiment. As seen in the table, the mean results of the post-test scores of the respondents in contest-type was 31.85, timed drill practice was 30.60, taped problems was 28.15 and traditional approach was 27.25 reflect marginal difference. It can also be seen that the level of mastery of the respondents were *approaching proficiency* and *developing* for contest-type and timed drill practice respectively, while both *beginning* for taped problems and traditional approach.

This indicates that respondents exposed to the modalities improved their mastery learning. This claim is supported by the result of their responses taken randomly on IRF worksheet when asked with the following questions:

Question No. 1: What is the rule for adding polynomials?

CT: "In adding polynomials we should remember that we must add the same sign and copy its sign but if there are different sign we should subtract it and copy the sign of a higher number."

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TDP: "To add polynomials, combine similar terms and get the sum of the terms with the same number and letter."

TP: "Align the polynomials, add if sign is same and subtract if it is not the same."

TA: "Aline a similar terms then get the sum."

Question No. 2: What is the sum of $3x^2$ - 11x + 12 and $18x^2$ + 20x – 100? How did you come up with the answer?

CT: "21x2 + 9x – 88. I come up this answer because first I used to arranged them with their same variable and proceed in the addition rule that the same sign we should add and copy its sign but we should subtract it and copy the sign of the higher number if they have different signs."

TDP: "21x2 + 9x – 88 I arranged them with their same variable then I add them and copy the sign of the same variable."

TP: "$21x^2$+ 9x - 88 first I add the first term and subtract the second term and I subtract the 3rd term."

TA: "$21x^2$+ 9x - 88 aline the polynomials then add get the answer."

Question No. 3: In subtracting polynomials, after changing the sign of the subtrahend, why do we need to proceed to addition rule, since it is subtraction?

CT: "Because the rule of the subtraction of polynomials is adding the negative of the quantity."

TDP: "Because that is the rule of subtracting polynomials. We have to changed first the sign of the subtrahend and then proceed to addition."

TP: "Because we change the sign so that we need to proceed to addition."

TA: "Because we change the sign of the subtrahend then we need to change the operation to get the correct answer."

Question No. 4: In the question, "What is $12x^3$ - $5x^2$ + 3x + 4 less than $15x^3$ + $4x^2$ + 10x – 10, which is the minuend and why?"

CT: "The minuend is $15x^3$+ $4x^2$ + 10x – 10 because it is written after the word less than."

TDP: "$15x^3$+ $4x^2$ + 10x - 10 because it is bigger than the other one."

TP: "$12x^3$ - $5x^2$ + 3x + 4 is the minuend because it less than subtrahend."

TA: "The minuend is $12x^3$ - $5x^2$ + 3x + 4."

Question No. 5: What is the most important property that you have to remember in multiplying polynomials? Why?

CT: "The most important property in multiplying polynomials is the Distributive Property because in this property we distribute the monomial to the other terms in polynomials."

TDP: "The distributive property because it distributes when we multiplying three or more terms."

TP: "The distributive property because it is needed in multiplying."

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TA: "For me we must remember that in multiplying same sign it is always positive and multiplying different sign is always negative."

Question No. 6: If you multiply (2x + 3) and (x – 7) by FOIL method, do you see any similar terms? What are they?

CT: "Yes I see similar terms they are the -14x and 3x because they have similar variables even they have different signs."

TDP: "There are similar terms -14x and 3x."

TP: "Similar term are -14x and 4x."

TA: "There are no similar terms."

Question No. 7: What is the rule in dividing a polynomial by a monomial?

CT: "To divide polynomial by a monomial, simply divide each term of the polynomial by the given divisor."

TDP: "Simply divide each term of the polynomials by the given divisor."

TP: "Divide term by the given divisor."

TA: "Divide each term of the polynomial by the given divisor."

Question No. 8: What is the cycle in long division?

CT: "The cycle in long division is checking the dividend and the divisor if it is in standard form. Setup the long division symbol where the divisor is outside the division symbol and the dividend inside it. You may now start the division, multiplication, subtraction and bring down cycle."

TDP: "Setup the long division by writing symbol where divisor is outside and dividend inside. Start dividing, multiplying, subtracting and bring down cycle. You can stop the cycle when the quotient has reached the constant term."

TP: "Check the dividend and the divisor if it is sign is standard form. Setup long division symbol.

TA: "Setup the long division then start to divide then multiply, subtraction and bring down cycle until you get the answer."

The responses above gave an indication of the subjects' mastery of the operation on polynomials. It shows that the respondent in contest-type mentioned some of the required concepts in his/her explanation but provides complete and correct answers. It supports their mean scores of 31.85 at *approaching proficiency* level. While the respondent in timed drill practice group mentioned only a few of the required concepts in their explanation and provides incomplete answers they were at the *developing* level. And although the respondents in taped problem group and traditional approach group were still at the *beginning* level, they were still able to give some correct answers. Sample answered IRF Worksheets were also presented (see Appendix F).

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Part IV. Significant Gain in the Mastery Learning of the Students Based on the

Post-test results in the four strategies of teaching

This section presented the comparison of the results of the four learning groups using Analysis of Variance (ANOVA). From this, the researcher tested the hypothesis of there is a significant difference in the mastery learning of the students in the four learning groups exposed to the four approaches to teaching based on the post-test result.

Table 4

Summary of Significant Gain in the Mastery Learning of the Students Based on the Post-test results in the four strategies of teaching

Source of Variation	SS	df	MS	F stat	P-value	F critical	Interpretation
Between groups	272.2375	3	90.74583	4.770645	0.004229	2.724944	
Within groups	1445.65	76	19.02171				Significant
Total	**1717.888**	**79**					

The table from the previous page shows that the post-test scores of the four learning groups differ significantly since the P-value of 0.004229 is less than the set level of significance of 0.05 while the F computed value of 4.770645 is greater than the F critical value of 2.724944. This indicates that the various modalities are effective in improving students' mastery learning in mathematics specifically in the operations on polynomials. This result supported the Cognitive Load Theory wherein modalities lessen the cognitive load of the working memory and helps the students master certain facts.

Since that the P-value corresponding to the F-statistic of one-way ANOVA is lower than 0.05, it suggested that two or more modalities are significantly different. To further identify which of the pairs of modalities are significantly different from each other, Tukey Post-Hoc Test was used. It is a multiple comparison test to determine the individual means which are significantly different from a set of means. Table 5 shows the Tukey Post-Hoc test results between the four modalities of math fact fluency.

Table 5

Tukey Post-Hoc Test Results between the Various Math Fact Fluency Modalities

(I)Modality	(J)Modality	Mean Difference (I-J)	Q-stat	p-value	Interpretation
Contest-Type	Timed Drill	1.25	1.2817	0.7771749	Not Significant
Contest-Type	Taped Prob-lems	3.7	3.7940	0.0435060	Significant
Contest-Type	Traditional Approach	4.6	4.7168	0.0070819	Significant
Timed Drill	Taped Prob-lems	2.45	2.5122	0.2928009	Not Significant
Timed Drill	Traditional Approach	3.35	3.4351	0.0803507	Not Significant
Taped Problems	Traditional Approach	0.9	0.9229	0.8999947	Not Significant

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As can be seen in the table, from the four modalities, six pairs were tested to determine which of the modalities exhibits statistically significant difference. The pairs between contest-type and timed drill practice, timed drill and taped problems, timed drill and traditional approach, and taped problems with traditional approach shows no significant difference since the computed p-value of 0.7771749, 0.2928009, 0.0803507 and 0.8999947 respectively, is greater than 0.05 level of significance. On the other hand, contest-type and taped problem have a p-value of 0.0435060 and contest-type and traditional approach has a p-value of 0.0070819 show a significant difference on the mastery learning of the students in mathematics since the computed p-value is less than the level of significance.

Clearly, the contest-type group has the most improved mastery learning in mathematics among the other modalities. Moreover, it can be concluded that it is the most effective modality of math fact fluency in improving students' mastery learning in mathematics.

Part V. Significant Gain in the Mastery Learning of the Learning Groups Exposed to the Modalities before and after the Implementation of the Treatment

This section presents and analyses the performance of the students exposed to contest-type, timed drill practice, taped problems and traditional approach. The performance of the four groups was measured and compared using t-test for correlated means at 0.05 level of significance.

Table 6 on the following page shows the t-test results between the pre-test and post-test of the group exposed to contest-type, timed drill practice, taped problems and traditional approach to teaching. From these data, the researcher determined whether the students have acquired learning in the operations of polynomials after the four modalities were employed independently.

Table 6

Summary of Significant Gain in the Mastery Learning of the Learning Groups Exposed to the Modalities before and after the Implementation of the Treatment

Group	n	Mean		Mean Difference	t-value	Interpretation
		Pre-test	Post-test			
Contest-type	20	13.3	31.85	18.55	20.44	Significant
Timed Drill Practice	20	12.55	30.6	18.05	18.89	Significant
Taped Problems	20	13	28.15	15.15	13.60	Significant
Traditional Method	20	12.35	27.25	14.90	13.07	Significant

t-critical = 2.093, df = 19

As can be seen in the table, contest-type group gain a mean difference of 18.55 and through further computation made using t-test; it revealed the computed t-value of 20.44. This indicates that there is a considerable gain in the mastery of the respondents under this modality. These findings contradict the statement of Olitsky as cited in Jones (2015) that a competitive classroom hinders education for students.

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Table 6 above showed that respondents exposed to contest-type modality gained the highest mean difference among the four groups. Thus, explains that students learned and mastered the operations on polynomials in spite of the opportunity to fail in each set of competition.

On the other hand, the results of the respondents exposed to timed drill practice signified that the respondents performed well in the post-test and registered a positive improvement in reference to their previous test. This means that there is enough evidence that the use of timed drill practice improved the mastery learning of the students. The findings confirm with the study of Coding, Burns & Lukito (2011) that interventions that contain the components of practice with modeling and drill result produced the largest treatment effects.

Moreover, respondents exposed to the taped problem and traditional approach also showed improvement in the pre-test and post-test mean result. With a mean difference of 15.15 and 14.90 for taped problem and traditional approach respectively, considerable evidence showed that the respondents registered significant gains in the mean results of the test of understanding. The result corresponds to the study of Aspiranti et al., (2011) that although the taped problem was effective for most students, the procedure of taped problem was clearly not effective to some students. But, the use of this modality contributes to the growing evidence base for taped interventions for initial acquisition of math facts. While for the traditional approach, the result attributed that traditional approach is time-tested and can be reliable to improve that mastery learning of the students.

Generally speaking, result shows significant difference between the pre-test and post-test of the four groups since the computed t-values such as 20.44 for contest-type, 18.89 for timed drill practice, 13.60 for taped problems and 13.07 for traditional approach are greater than the t-critical value of 2.903 aside from that the P-values are less than 0.05 level of significance. There is an increase in mastery learning from the pre-test and post-test intervention. This implies that the various modalities of math fact fluency had effect on the improvement of students' mastery learning in mathematics.

Part VI. Improvement in the mastery learning of the students in each group with the use of modalities as perceived by the teacher-observers

Performance of each group showed improvement through the quantitative results gathered in the study. Aside from that, teacher-observers perceived greater improvement not just in their cognitive ability but also in their personality as well. This was shown in the comments of the observers in each learning group.

Contest-type

Observer 1: Students were motivated since a game was incorporated in the class discussion.

Observer 2: Integrating contest-type makes the students participate in the discussion and was very lively during the group contest.

Timed drill practice

Observer 1: In timed drill practice, the willingness of the students to answer was boosted on the allotted period of time given to them.

Observer 2: Students' interest was sustained throughout the period.

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Taped problem

Observer 1: The taped problem is a new activity for the students. It helps them to be attentive and encourage beating the taped.

Observer 2: Active participation of the students was observed.

Traditional approach

Observer 1: Learners were able to understand the lesson and most of the learners actively participated in the class.

Observer 2: The students were able to explain their works showing that they understand the lesson.

The results of the STAR observation (see Appendix H) showed that students were able to understand the lesson through the use of the modalities. Active participation of the students demonstrated an outstanding improvement in their performance. Aside from that, students developed the willingness to learn and be motivated to study mathematics. Moreover, they were attentive and interested to listen. The skills and attitude attained by the students proved that they improve their mastery learning in mathematics.

Conclusion

In light of statistical analysis and findings of the study, the following conclusions were drawn:

1. There are no significant differences in the pre-test results of the learning groups since the mastery learning of the students were at the same level of proficiency, they have no prior knowledge before being exposed to the modalities.

2. There are significant differences in the mastery learning of the students in the four strategies of teaching based on the post-test results. This indicates that among the various modalities the contest-type is the most effective in improving students' mastery learning in mathematics.

3. The mastery learning of the students exposed to the modalities may be described using the results of their pre-test and post-test. From the *beginning* level of mastery learning in the pre-test, the students achieved the *approaching proficiency* and *developing* level in the post-test.

4. There are significant differences between the pre-test and post-test results of the learning groups. This proves that either of the various modalities employed; there will be a significant improvement in the mastery learning of the students.

Recommendations

From the findings and conclusions derived from the study, the following recommendations are offered for consideration:

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1. The various modalities of math fact fluency may use in teaching operations on polynomials as well as other topics involving the four fundamental operations.

2. Since some students experience difficulties in the modalities assigned to them, it is highly recommended to use combinations of modalities in teaching operations so that students can choose which modality could help them and which they find easy to use depending on their interest and mental ability.

3. Mathematics teachers should be encouraged to use modalities in teaching operations involving math facts.

4. Concerned stakeholders in mathematics education may provide trainings for the teachers in which the use of modalities of math fact fluency is facilitated.

5. Further study that will analyze math fact fluency modalities on students' mastery learning should be conducted. In addition, future researchers are encouraged to use other modalities that may help students further deepen their understanding on mathematics subject and make them fluent in math facts.

References

A. Journals

Arnold, K. (2012). Theoretical Frameworks for Math Fact Fluency. *Journal of the American Academy of Special Education Professionals*, 28-33. Retrieved at https://eric.ed.gov/?id=EJ1135680

Ke, F. & Grabowski, B. (2007). Game playing for maths learning: cooperative or not? *British Journal of Educational Technology, 38*(2), pp. 249-259. doi: 10.1111/j.1467-8535.2006.00593.x

McCallum, E. Skinner, C. H., & Hutchins, H. (2004). The taped-problems intervention: Increasing division fact fluency using a low-tech self-managed time-delay intervention. *Journal of Applied School Psychology*, 20(2), 129-147

Miller, K. C., Skinner, C. H., Gibby, L., Galyon, C. E., & Meadows-Allen, S. (2011). Evaluating Generalization of Addition-Fact Fluency Using the Taped-Problems Procedure in a Second-Grade Classroom. *Journal of Behavioral Education,* 20(3):203-220. doi:10.1007/s10864-011-9126-9. Retrieved November 13, 2016 from https://www.researchgate.net/publication/225842788

B. Published Theses and Dissertations

Ezbicki, K. (2008). *The effects of a math-fact fluency intervention on the complex calculation and application performance of fourth grade students* (*Doctoral Dissertation).Available from ProQuest Dissertations and Theses Database.* (UMI No. 3325323)

Fu, J. (2011). *A teaching study on using math games to improve student's learning interest in a junior middle school* (Master's Thesis). Available from *ProQuest Dissertations and Theses Database*

ISSN Print: 2984-8288
ISSN Online: 2984-8385

Knowles, N. P. (2010). *The relationship between timed drill practice and the increase of automaticity of basic multiplication facts for regular education sixth graders* (Doctoral Dissertation). Retrieved July 31, 2016 from http://scholarworks.waldenu.edu/dissertations

Lorchak, H.C. (2010). *Improving Multiplication Fact Flency among High School Studetns with Learning Disabilities* (Doctoral Dissertation).Retrieved from https://etda.libraries.psu.edu/catalog/10312

McCallum, E. (2006). *The Taped-Problems Intervention: Increasing Multiplication Fact Fluency using a Low-Tech Time Delay Intervention* (Doctoral Dissertation). Available from ProQuest Dissertations and Theses Database. (UMI No. 3235498).

Orefice, F. (2013).*The Effects of Timed Multiplication Fact Drills on 5th Graders' Ability to Master, Maintain and Apply Their Multiplication Facts to Higher- Order Thinking Problems That Require Multiplication to Solve.* (Master's Thesis). Available from ProQuest Dissertations and Theses Database.(UMI No. 1537116).

C. Unpublished Theses

Cabuhat, Josephine L. (2016). Strengthening the Competencies of Grade 7 Students on Selected Topics in Mathematics through the Use of Different Teaching Strategies. (Unpublished Master's Thesis, Bulacan State University).

Iglesia, Angelita R. (2012). Enhancing Students' Reasoning Ability and Proof Construction Skills in Geometry via Modified Worked Examples. (Unpublished Master's Thesis, Bulacan State University).

Mendoza, Anthony (2011). Effects of Various Modular Based Instructional Approaches in Level of Achievement of students in Geometry. (Unpublished Master's Thesis, Bulacan State University).

D. Electronic References

Ashcraft, M. (2002). Math anxiety: Personal, educational and cognitive consequences. *Current Direction in psychological Science*, 11(5), 181-185. Retrieved athttp://cdp.sagepub.com/content/11/5/181

Aspiranti, K. B., Skinner, C. H., McCleary, D. F., &Cihak, D. F. (2011). Using Taped-Problems and Rewards to Increase Addition-Fact Fluency in a First Grade General Education Classroom. *Article from Behavior Analysis in Practice*, 4(2): 25–33. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3357097/

Babbie, Earl R. (2010). *Doing Quantitative Research in Education with SPSS*.2nd edition. London: SAGE Publications, 2010. Retrieved October 1, 2016 athttp://libguides.usc.edu/writingguide/quantitative

Cameron, R., (2014). *Mixed Methods Research*. Retrieved from https://www.deakin.edu.au/____data/assets/pdf_file/0020/681023/Dr-r-cameron_mixed-methodology.pdf

ISSN Print: 2984-8288
ISSN Online: 2984-8385

Carroll, E., Skinner, C. H., Turner, H., McCallum, E., &Woodland, S. (2006). *Evaluating and comparing responsiveness to two interventions designed to enhance math fact fluency*. School Psychology Forum: Research in Practice. 1:28–45.

Codding, R. S., Burns, M. K., &Lukito, G. (2011). Meta-analysis of mathematic basic-fact fluency interventions: A component analysis. *Learning Disabilities Research & Practice*, 26(1), 36-47. doi: 10.1111/j.1540-5826.2010.00323.x

Cohen, L., Manion, L., & Morrison, K. (2007). *Research methods in education.* New York: Routledge.

Dela Cruz, Mario James S., (2017, March 11). *Science ed and a thinking society.* Philippine Daily Inquirer. Retrieved from https://www.pressreader.com/philippines/philippine-daily-inquirer/20170311/281754154122594

Guskey, T. R. (2010). Lessons of Mastery Learning.*Educational Leadership*, *65*(4), 28–35. Retrieved from http://www.ascd.org/publications/educational-leadership/oct10/vol68/num02/Lessons-of-Mastery-Learning.aspx

Jones, J. V. (2015). *How Do Games and Competition Impact Student Motivation in the Mathematics Classroom?* (Master's Research Project, Ohio University College of Education and Human Services). Retrieved at https://www.ohio.edu/education/academic-programs/upload/JaredJones_MastersReseachProject.pdf

Mastery Learning.(n.d.). In *Wikipedia The Free Encyclopedia*. Retrieved from https://en.wikipedia.org/wiki/Mastery_learning

McCallum, E., Skinner, C. H., Turner, H., &Saecker, L. (2006). The Taped Problems Intervention: Increasing Multiplication Fact Fluency Using a Low-Tech, Classwide, Time Delay Intervention. *School Psychology Review*. 35(3), 419-434. Retrieved on July 2, 2016 from https://www.researchgate.net/publication/234640232

Powell, S.D. (2013). Learning Modalities. *Introduction to Middle School, 2005 edition, p.62.* Retrieved from http://www.education.com/reference/article/learning-modalities/

Rusczyk, R. (2017) Pros and Cons of Math Competitions. Retrieved March 25, 2017 from https://artofproblemsolving.com/articles/competitions-pros-cons

SEI-DOST & MATHTED, (2011). *Mathematics framework for Philippine basic education*. Manila: SEI-DOST & MATHTED.

Woodward, J. (2006). *Developing automaticity in multiplication facts: Integrating instruction with timed practice drills*. Learning Disability Quarterly, 29(4), 269-289. Retrieved November 13, 2016 from http://ldq.sagepub.com/content/29/4/269.abstract

Wyse, S. E. (2011). What is the Difference between Qualitative Research and Quantitative Research? *Snap Surveys.* Retrieved from http://www.snapsurveys.com/blog/what-is-the-difference-between-qualitative- research-and-quantitative-research/