The Normal Lights
Volume 13, No. 2 (2019)

Modified Alternative Co-teaching Approach: Effects on Student Procedural Fluency in Algebra

Ann Jelin G. Angeles
adgonzales3@up.edu.ph
University of the Philippines Los Baños, Philippines

Ma. Nympha B. Joaquin
nymphajoaquin@yahoo.com
University of the Philippines Diliman, Philippines

May Ann B. Lapitan
mblapitan@up.edu.ph
University of the Philippines Los Baños, Philippines

Rina A. Mabilangan
ramabilangan@up.edu.ph
University of the Philippines Los Baños, Philippines

Aprhodite M. Macale
ammacale@up.edu.ph
University of the Philippines Los Baños, Philippines

Abstract The study investigated the effects of the Modified Alternative Co-Teaching Approach (MACTA) on student algebraic procedural fluency (the ability to perform mathematical algorithm accurately and efficiently). The study used the quasi-experimental two-group pretest-posttest design that involves both quantitative and qualitative approaches. The study utilized two intact classes of a laboratory school in Bay, Laguna. One section was exposed to the Modified Alternative Co-Teaching Approach (MACTA) and the other section was exposed to the Conventional Teaching Approach (CTA). Comparison of the student algebraic procedural fluency between MACTA and CTA groups showed no significant difference between the two groups, but students in the experimental group expressed substantial number of positive remarks about the teaching approach. The design of MACTA including smaller class size, more student-student interaction, and increased collaborative activities is believed to promote procedural fluency, and positive attitude, better with longer term of implementation.

Keywords: alternative co-teaching, class size reduction, co-teaching, peer teaching, procedural fluency

Suggested Citation: Angeles, A.J.G., Joaquin, M.N.B., Mabilangan, R.A., Macale, A.M., & Lapitan, M.A.B. (2019). Modified Alternative Co-teaching Approach: Effects on Student Procedural Fluency in Algebra. *The Normal Lights*, 13(2), 90 – 110.

Introduction

The industrial revolution we are now in has changed the job landscape our students are preparing for in 2022 (Bin & Ngoc, 2019). As a response, the mathematics classroom should be more focused on innovation and value than merely knowledge creation. Twenty first century mathematics classroom should be characterized by activities which foster communication, collaboration, creativity, and critical thinking. Group activities foster conversation and interaction with peers while solving and justifying problems. This is in line with the finding of Mathematics Education, Inc. and Science Education Institute-DOST (2011) that students can better learn mathematics and practice collaboration skills with their peers. Furthermore, the social dimension of learning as related to the classroom environment are believed to affect student achievement and attitude towards mathematics. Collaborative mathematics and communicating mathematics with peers and teachers can deepen students' understanding of mathematics. However, this can be dampen with large class size and inavailability of spacious facility. A possible solution to this situation is to break the big class into small groups which will be taught using the co-teaching approach.

Co- Teaching Approach

Co-teaching is commonly used to make sure that students with special needs in a general education setting complete the same curriculum, and at the same time receive specialized instruction. In this approach, general education teachers and special education teachers combine their expertise, share materials, and develop common objectives (Friend, Cook, Hurley-Chamberlain, & Shamberger, 2010). Alternative co-teaching, one of the co-teaching models, may positively affect the students' academic achievement because it can offer remediation, review, enrichment, additional practice, re-teaching, and reduction of class size (Almon & Feng, 2012).

In the alternative co-teaching model, the class is actually divided into two groups: one larger and one smaller. This strategy provides two different approaches to teach the same content. The teachers make sure that the students receive the same information so that the learning outcome will be the same for all of the students (Aliakbari & Bayzar, 2012). In this model, co-teachers would teach a smaller group 15-20 minutes every session in a more detailed and explicit way. This happens in another room as the other co-teacher teaches the remaining students in class (larger group) (Sileo & Van Garderen, 2010). Alternative co-teaching is a model that reduces the student – teacher ratio, which is known to significantly affect the achievement and performance of the students (Mathis, 2016). In the case of Almon and Feng's (2012) study, the general education teacher would divide the class into two groups and the special education teacher would teach the half of the class outside the classroom for about 20-30 minutes. The teachers also tried to use the 'one teach, one assist model', but the approach appeared to delay the learning. Additionally, a focus on alternative co-teaching's effort on students grammar achievement (Kolahi & Safari, 2014) showed that the model has a significant positive effect on the students' grammar achievement.

Although alternative co-teaching is a very promising instructional strategy, it is not feasible to apply in the Philippines due to the shortage of teachers with the implementation of the K to 12 program (Pazzibugan, 2013). Fortunately, there is evidence that the utilization of peer teachers or peer tutors inside the class is beneficial to the students as well. (Bowmann-Perrott et al., 2013).

Peer Teaching

Peer teaching is an instructional strategy, which occurs when an expert student, helps a novice student, when students are randomly paired to each other, or when an older tutor is paired with a younger tutee (Grubbs & Boes, 2009). In one meta-analysis, where the effect of peer teaching to student achievement in several subject areas was examined, it was indicated that a large effect

size (.86 and .92) was gained in vocabulary and mathematics, respectively. It was concluded that students involved in peer teaching interventions gained more than the students in non-peer teaching setup (Bowmann-Perrott et al., 2013).

While there is an abundance of studies on the effect of co-teaching on mathematical achievement, there is a dearth of knowledge about other key aspects like mathematical proficiency and its components. A very critical component of mathematical proficiency is procedural fluency.

Procedural Fluency

The National Council of Teachers of Mathematics (NCTM) detailed procedural fluency, as the ability "to transfer procedures to different problems and contexts; to build or modify procedures from other procedures; and to recognize when one strategy or procedure is more appropriate to apply than another" (NCTM, 2014, p. 1). It also includes, but is not limited to, algorithms – which are the steps needed to perform mathematical operations. This strand is what the students need to be most familiar with to achieve a level of automaticity. This will allow the students to explore mathematical ideas that they will encounter. That is why there is a need to develop the students' procedural fluency because of the limited capacity of their working memory. If their procedural fluency is developed, the load of their working memory will be reduced, resulting in more memory capacity to perform other mathematical actions (Sullivan, 2011).

Related literature revealed that there is a great amount of studies regarding the effect of alternative co-teaching to mathematics achievement, but clearly, there is a lack of research regarding procedural fluency. In light of the present predicament to improve the competency of the Filipino students in mathematics, these areas are worth exploring.

It is believed that the model is significant to several

stakeholders like teachers, students, administrators, and researchers. If found to be a viable alternative to the traditional teaching method, the Modified Alternative Co-Teaching Approach (MACTA) can be employed by mathematics teachers to improve the algebraic procedural fluency of their students. Additionally, this teaching approach can address the student-teacher ratio considering the prevalent practice of large classes in public high schools. For the administrators, this intervention may help in close monitoring of student performance and to alleviate student academic delinquencies. This teaching approach can also be a way to reduce the class size without increasing the financial cost per student since peer teachers will serve as co-teachers. If proven effective, this teaching strategy could also improve the scores in the mathematics subtest of standardized examinations, such as the National Achievement Test (NAT).

Purpose of the Research

The study investigated the effects of the modified alternative co-teaching approach on student procedural fluency. Specifically, the study sought answers to the research question: $_1$Is there a difference in algebraic procedural fluency between students exposed to Modified Alternative Co-Teaching Approach and those exposed to Conventional Teaching Approach?

Methodology

Research Design

This study used a quasi-experimental two-group pretest-posttest design with two intact classes to test the effectiveness of Modified Alternative Co-Teaching approach on student procedural fluency in algebra. The researchers exposed the first group to Modified Alternative Co-Teaching Approach (MACTA) and the second group to Conventional Teaching Approach (CTA).

Participants

The researchers conducted the study at a laboratory high school located in Bay, Laguna. There were 488 students enrolled in the said laboratory school from grades 7 to 10 during the academic year 2015-2016. Each grade level has four mathematics sections, one advanced and three regular sections, with approximately 30 students in each section. In order to examine the effect of the teaching approach to student algebraic procedural fluency, grade 8 students were chosen to participate in the study. The said laboratory school offers Intermediate Algebra in grade 8. Two regular mathematics sections with 30 students each participated in this study. There were no significant differences among the third quarter grades of the three grade 8 regular mathematics sections. Because of this, the two participating classes were selected based on the grade 8 similarity of student abilities and characteristics. Moreover, to identify the experimental group, draw-lots technique was used.

The researcher and the grade 8 mathematics instructor selected two students who served as peer teachers in this study. The selection of peer teachers was based on the following criteria: (1) the students' third quarter mathematics grade, (2) the students' willingness to be peer teachers, and (3) the preferred peer teacher of the class. They also determined the pairings of the MACTA students to be used all throughout the study.

The researcher and the grade 8 mathematics instructor paired the remaining students based on their third quarter mathematics grades. The student with the highest mathematics grade was paired with the student with the lowest mathematics grade. They also paired the student with the second highest mathematics grade with the student with the second lowest mathematics grade. The members of the small groups were the pairs that include the four students with the highest third quarter mathematics scores, four students with the lowest third quarter mathematics scores and the peer teachers. One small group consisted of two pairs of students and one peer teacher.

The Instrument

The instrument used was the Algebraic Procedural Fluency Test (APFT), which was a researcher-made multiple-choice test. The APFT originally consisted of 40 multiple-choice items. The content of APFT was content validated by a panel of experts. Revision of the test reduced the items to 20. APFT was then revised based on the result of the pilot test and the number of items was then reduced to 20 items.

Teaching Approach

In this study, two approaches were used: the Modified Alternative Co-Teaching Approach (MACTA) and the Conventional Teaching Approach (CTA).

Modified Alternative Co-Teaching Approach (MACTA)

Due to the nature of the Alternative Co-teaching Approach (ACTA) where the class is divided into two – one large group and one small group—it is possible to target novice students and give them more individualized instruction that can possibly improve their algebraic procedural fluency. Since it is not practical to apply ACTA in the Philippine setting, where there is a shortage of teachers, the ACTA was modified and applied on the MACTA group every meeting for seven sessions. The modifications were the following: (1) instead of having a mathematics teacher and a special education teacher to co-teach, a mathematics teacher and two peer teachers handled the class, (2) instead of having two groups, one large and one small group; the class was divided into three groups, consisting of one large group handled by the instructor and two small groups each handled by a peer teacher, (3) the small groups were taught at different venues during discussions, and (4) the students were paired all throughout the session. In case of an absent student, the individual without a partner joined another pair, resulting in a group of three students.

Conventional Teaching Approach (CTA)

The CTA group was given classroom discussions led by the instructor with group activities and evaluation, which followed the grade 8 math course outline provided by the laboratory high school.

Data Collection

The researchers asked the permission of the principal of the laboratory high school to involve two grade 8 sections in the study. An informed consent was secured from the student participants. They also sent letters to the parents of the students for their consent. The researchers also oriented the students regarding the study after all student permits were submitted. After determining the experimental and control groups, the researchers administered the pretest to the 30 students in the control group and to the 30 students in the experimental group.

For the whole 4th quarter, the mathematics instructor handled the control group. The researchers and the instructor divided the experimental group into three groups – one large and two small groups. The same mathematics instructor taught the large group in the MACTA class, consisting of 10 pairs (20 students) of students, while the peer teachers handled the two small groups. Each small group consisted of one peer teacher and two pairs (four students) of students. In this intervention, one of the researchers acted as an observer of the two small groups and the CTA group. The instruction of MACTA group followed the course outline used for grade 8 math of the laboratory high school. The peer teachers and the mathematics instructor gave the same topic, instruction and evaluation to the MACTA and CTA group. The researchers employed the intervention in the students' algebra classes, which were scheduled 1.5 hours every Tuesdays and Thursdays of the week. One of the researchers and the mathematics instructor met with the two peer teachers every Friday and Monday to teach the topic to be discussed the following Tuesday and Thursday,

respectively. The exercises assigned for the particular topic were given to the peer teachers during these meetings. The mistakes they committed were explained and clarified by the instructor. The peer teachers were also instructed on how they are going to teach the topic to students. Their inputs to how the topics will be taught to the students were also solicited. On the other hand, the CTA group was given classroom discussions led by the instructor with group activities and evaluation, which followed the grade 8 math course outline. Table 1 shows the comparison of MACTA and CTA class.

Table 1. Comparison of MACTA and CTA Lesson Plan

MACTA	CTA
Before the class One of the researchers and the mathematics instructor meet with the peer teachers to teach them the topic to be discussed. The peer teachers answer the exercise assigned for the particular topic discussed. Peer teachers co-plan with the instructor by suggesting ways to how the topic can be discussed to the students.	
During the class I. Preparatory Activities (All groups will be facilitated by the teacher in the main classroom.) A. Greetings B. Checking of attendance C. Checking of exercise and review	During the class I. Preparatory Activities A. Greetings B. Checking of attendance C. Checking of exercise and review
II. Discussion The members of the two small groups and their respective peer teachers will transfer to another venue. The teacher will instruct the large group while the peer	II. Discussion The teacher will instruct the class.

teachers will teach the two small groups.	
III. Practice Items Practice items are given to the students. The teacher facilitates the large group while peer teachers facilitate the two small groups.	III. Practice Items Practice items are given to the students.
IV. Evaluation The students will go back to the main classroom where the teacher gives their exercise. Peer teachers contribute to the assessment of the students on their respective groups.	IV. Evaluation An exercise will be given by the teacher.

The thirty 30 students in the control group and the thirty (30) students in the experimental group (20 students from the large group and 10 students from the two small groups) were posttested after the intervention. The researchers asked the students from the experimental group to write and describe their experiences and assessment on the experiment in their journals. Their answers were used for the qualitative analysis of the study.

Data Analysis

This study employed quantitative and qualitative analysis of data. It applied parametric statistics to quantitatively analyze the data. The hypothesis was tested at .05 level of significance. The researchers collected the comments of the students to analyze the results qualitatively.

The researchers used a two-tailed t-test for independent samples on the mean pretest scores of the instrument to establish the initial comparability of the two groups – the MACTA group and the CTA group. They also performed another two-tailed t-test for independent samples on the mean posttest scores of the two

groups after the intervention since the two groups were found to be initially comparable, thus negating the need for a comparison of gain scores. This is to determine if the students in MACTA group has a significant difference in their algebraic procedural fluency compared to the students in CTA group.

Results and Discussion

The study investigated the effects of the Modified Alternative Co-Teaching Approach (MACTA) on the students' algebraic procedural fluency. This section presents how MACTA compares with CTA. Table 2 presents the descriptive statistical analysis of the Algebraic Procedural Fluency Test (APFT) pretest for both groups.

Table 2. T-test for initial comparability on mean pretest scores of MACTA and CTA groups in algebraic procedural fluency test

Group	n	Mean	SD	t	df	p
MACTA	30	7.90	2.60	.706	58	.483*
CTA	30	7.47	2.13			

Note: APFT Perfect Score = 20 point

**The result indicates that there is no statistically reliable difference between the mean pretest scores of the students from the MACTA group and CTA group in terms of algebraic procedural fluency before the intervention (t(58) = .706, p = .483)*

Table 3 presents the means and standard deviations of the Algebraic Procedural Fluency Test (APFT) posttest for both groups, including the computed t-value at .05 level of significance. The mean posttest score for MACTA group (M = 12.73, SD = 3.04) was greater than the mean posttest for CTA group (M = 12.43, SD = 4.00). The researcher failed to reject the null hypothesis that there is no significant difference between the mean posttest scores of the students exposed to Modified Alternative Co-Teaching Approach and those exposed to Conventional Teaching Approach in the Algebraic Procedural Fluency Test.

Table 3. T-test for significant difference on mean posttest scores of MACTA and CTA groups in algebraic procedural fluency test

Group	n	Mean	SD	t	df	p
MACTA	30	12.73	3.04	.327	58	.745*
CTA	30	12.43	4.00			

Note: APFT Perfect Score = 20 point

**The result indicates that there is no significant difference between the mean posttest scores of the students from the MACTA group and CTA group in terms of algebraic procedural fluency after the intervention (t(58) = .327, p = .745).*

Although there is no statistically reliable difference between the APFT posttest scores of the two groups, it can be noted that the students in MACTA small groups expressed positive remarks regarding the teaching approach.

> *"I think this type of learning is more helpful to me because I can communicate easily with the peer teacher and I honestly believe that this helped me to excel more in Mathematics and can make my grades higher."*
>
> *-Student 1*

> *"Sobrang gumana siya sa akin. Naintindihan ko ng sobra yung mga lessons. (It worked for me really well. I very much understood the lessons.)"*
>
> *-Student 5*

> *"Mas nagets ko po yung lessons nung peer teacher ako. (I was able to get [understood] the lessons when I was the peer teacher.)"*
>
> *-Student 9 (Peer Teacher)*

> *"Nagustuhan ko po yung experiment na ginawa. Para po sa akin bilang peer teacher, mas na-mamaster ko po yung lessons. (I liked the performed experiment. For me, as a peer teacher, I was able to master the lessons well.)"*
>
> *-Student 16 (Peer Teacher)*

> *"Mas naiintindihan ko po pag ganito ang set up natin. (I understood it more if this would be our setup.)"*
>
> *-Student 22*

These comments are evidence of the students' perceived increase in their mastery of the subject matter due to the change in the teaching approach. Students also expressed increase in participation and communication with each other. The remarks of the students validate the findings of Systma (2014) that peer teaching allows the students to gain control over their own learning. In effect, the enjoyment and class participation of the students increased especially from the students who encounter difficulties in their mathematics classes (Systma, 2014). Student 16, who was a peer teacher, expressed a positive remark towards MACTA. In peer teaching, peer teachers directly benefit from the strategy because the peer teachers strengthen and advance their prior learning (Ali, Anwer, & Abbas, 2015).

> *"It (the setup) opens us up so that we can easily voice out our problems – something we are not comfortable enough to do in a large class. I hope that next year, this teaching method will be taken to all classrooms to help the shy and "Math-challenged" children like me. ... I would absolutely recommend it!"*
>
> *-Student 5*

> *"It was beneficial because I was able to speak up in smaller groups whenever I didn't understand something. There were fewer judgmental people who would react because I didn't get it and there was a slower pace of discussion because the peer teacher was able to attend to our questions. She makes sure we understand the concepts before moving on a new subtopic. I feel like this setup would be better than a large classroom setup because this way, students can speak up without feeling so embarrassed or bad*

because of the short discussion delay."

-Student 17

Student request for replication of the intervention, such as the request of Student 5, is a support for substantial success of the teaching approach (Systma, 2014). Students felt more comfortable to ask questions and participate in discussions in MACTA group. This open communication happens because the students and the peer teacher communicate with each other in a very similar manner compared to the communication between a student and a teacher. The students in small group were freer in terms of expressing their opinions and inquiries. These interactions and increase in communication, according to Madhar (2013), suggest that students see the peer teacher as someone they can learn from and whose knowledge they can trust. The communication skills and self confidence of the students are also enhanced in this set-up as per the comment of Student 17, which confirm with the findings of Ali and colleagues (2015) that the benefits of peer teaching are not only evident in their grades but in their interpersonal skills as well. Students are more comfortable with their peers that result to a conducive learning environment (Ali et al, 2015).

In general, 83% of the students from the MACTA group (25 out of 30) positively receive the approach. Eighty percent of students from the MACTA small groups (8 out of 10) express positive opinion regarding the setup. But there are also students who cited negative remarks and reservations with regard to the approach. The following comments the negative comments solicited from the two small groups (2 out of 10 students).

"Ok lang naman po na may peer teacher. Ang naging problem ko lang po ay si partner. Natututo naman po ako kay peer teacher, pero I prefer po na teacher na lang ang magturo kasi po hindi po ganun karami yung knowledge nya about math. (It's ok to have a peer teacher. The only problem I had was with my partner. I was able to learn from the peer teacher but I prefer an

actual teacher teaching because the peer teacher does not have that much knowledge about math.)"

-Student 7

"Mas nakakaintindi ako kapag malaki ang room at mas maraming tao sa room.(I am able to understand more if the room is big and there are more people in the room.)"

-Student 12

Student 7 was one of the high achieving students from the MACTA section – student ranked second based on the third quarter mathematics grade. The researcher and the instructor were not able to assign student 7 as a peer teacher, considering the students' high mathematics grade, due to the unwillingness of the student to be a peer teacher. Student 7 was paired to a novice student, student 27. Colvin and Ashman (2010) identified the lack of trust of high performing students, such as student 7, to their peers as one of the risks of peer teaching. They stated that the competence and experience of the peer teachers as instructors are possible to be questioned by expert students because of the uncommon use and unfamiliarity of the students to the new setup. Less capable student paired to a high-performing student could also resist the help of his partner (Eskay, Onu, & Obidoa, 2012). The willingness of the students to grant the peer teachers the authority to teach them is one of the features of a successful peer teaching. The unwillingness of a student to grant his peer the authority to teach them is a reflection of the teacher-centered culture where the teacher has the right to teach, question, and command inside the classroom. This resistance emerges when the students do not understand the role of the peer teachers and the need for peer teaching (Colvin & Ashman, 2010).

The result stated above does not corroborate with the findings of some literatures where peer teaching showed positive effects on student learning. In particular, this outcome is in

contrast with the study of Joaquin (2012) where the findings showed that students exposed to cogenerative peer teaching approach significantly differed from the students in conventional teaching approach in terms of their problem solving skills. The non-significant outcome is also inconsistent with the result of another study that the reduction in class size should render a positive effect to student achievement in mathematics (De Paola, Ponzo, & Scoppa, 2013).

The non-significant difference in the mean posttest scores of APFT could be a product of the limited practice of the teaching approach given that the intervention was employed for seven meetings only. This was due to school activities and holidays scheduled during the period of the intervention. According to Portugal (2014), who also cited the same reason for the non-significant difference of the test scores between her experimental and control groups after intervention, this finding was the result of inadequate time for the students to get accustomed to the new teaching approach. The duration of the intervention was a limiting factor not only to the students but to the peer teachers as well because the peer teachers are just starting to get use to their new roles in class.

Another factor that could have affected the result and minimized the effect of MACTA on algebraic procedural fluency is the mastery of the peer teachers of the subject matter. In spite of pre-teaching the peer teachers, they may not have fully mastered the topic to be taught (Eskay et al., 2012).

An additional reason why there is no significant difference between the student algebraic procedural fluency of the two groups could be the non-variation of instructional method (McDuffie, Mastropieri, & Scruggs, 2009). Both the MACTA group and the CTA group were taught using direct instruction.

Another limiting factor was the non-measurement of the procedural fluency of the peer teachers prior their assignment as peer teachers. Instead, the researchers used their mathematics

grade and their willingness to be peer teachers as bases of assigning them.

Conclusion and Recommendations

This study was an attempt to examine the effects of Modified Alternative Co-Teaching Approach (MACTA) to student algebraic procedural fluency. The result of this study filled the gap on the researches regarding procedural fluency. This study provided the opportunity for the institution to lower the class size which promotes collaboration and conversation among the students (De Paola et al., 2013).

Both the conventional teaching approach and the modified alternative co-teaching approach proved to be effective methods to improve the algebraic procedural fluency of the students. The result of the study indicated that there is no significant difference between the algebraic procedural fluency of the students in MACTA and CTA groups. However, there was a substantial amount of positive responses from the students in MACTA group. Students experienced an increase in classroom participation and improved communication with their respective instructor and peer teachers. They felt more at ease and comfortable in expressing their ideas and difficulties in the MACTA class. The students also expressed perceived increase in mastery and understanding of the subject matter. The peer teachers participated in the experiment experienced reinforcement and advancement of their prior learning in algebra. The good feedback from the students is a strong indication that the intervention increased students' interest in learning mathematics (Systma, 2014).

One limitation of the study is the length of the conduct of the experiment. To fully measure the potential of the teaching approach employed in this study, it is recommended to use the intervention for a longer period of time, at least for two consecutive quarter periods. A longer period of investigation

improves the accuracy of the results and analysis (Maples, 2009). Another limiting factor of the study is the peer teacher's mastery of the subject matter. Thus, it is also recommended that peer teachers should be trained long enough to assure the development of their own procedural fluency. The instructor can also develop take-home exercises for the peer teachers to practice solving problems developing procedural fluency. Feedback should be provided to solve any indication of possible learning gaps (Stacey, Cartwright, Arwood, Canfield, & Kloos, 2017). It is also worthwhile to try assigning peer teachers to two or four students needing assistance. Another recommendation would be to use a different type of instrument to fully measure the procedural fluency of the students and to compare the score gains of the students from the small groups from the gains of those in the control group.

The researchers strongly recommend the replication of this study in schools having pilot sections. Students from the pilot section can serve as the peer teachers to other sections. The intervention could also benefit from mentor-intern partnerships. Instead of collaborating with peer teachers, instructors can collaborate with teacher candidates or pre-service teachers taking up their practicum courses.

…

References

Ali, N., Anwer, M., & Abbas, J. (2015). Impact of Peer Tutoring on Learning of Students. *Journal for Studies in Management and Planning, 1*(2), 61-66. Retrieved from: https://www.researchgate.net/publication/319292234_Impact_of_Peer_Tutoring_on_Learning_of_Students.

Almon, S., & Feng, J. (2012). Co-teaching vs. solo-teaching: Effect on fourth graders' math achievement. *Mid-South*

Educational Research Association Annual Conference, (p. 33). Kentucky.

Aliakbari, M., & Bazyar, A. (2012). Exploring the impact of parallel teaching on general language proficiency of EFL learners. *Journal of Pan-Pacific Association of Applied Linguistics, 16*(1), 55-71.

Bin, J.O.C & Ngoc, N.T.M. (2019, February). *The 4cs framework to transform higher education institution into an innovation producing ecosystem.* Paper presented at the 5th National Conference in Science and Mathematics Education "STEM" Towards Education 4.0, Legazpi City, Bicol, Philippines.

Bowmann-Perrott, L., Davis, H., Vannest, K., Williams, L., Greenwood, C., & Parker, R. (2013). Academic benefits of peer tutoring: A meta-analytic review of single-case reasearch. *School Psychology Review , 42* (1), 39-55.

Colvin, J.W., & Ashman, M. (2010). Roles, risks, and benefits of peer mentoring relationships in higher education. *Mentoring & Tutoring: Partnership in Learning*, 121-134.

De Paola, M., Ponzo, M., & Scoppa, V. (2013). Class size effects on student achievement: Heterogeneity across abilities and fields. *Education Economics , 21*(2), 135-153.

Eskay, M., Onu, V. C., Obiyo, N., & Obidoa, M. (2012). Use of peer tutoring, cooperative learning, and collaborative learning: Implications for reducing anti-social behavior of schooling adolescents. *US-China Education Review*, 932-945.

Friend, M., Cook, L., Hurley-Chamberlain, D., & Shamberger, C. (2010). Co-Teaching: An Illustration of the Complexity of Collaboration in Special Education. *Journal of Educational and Psychological Consultation*, *20* (1), 9-27 DOI:10.1080/10474410903535380.

Grubbs, N., & Boes, S. (2009). *The Effects of the Peer Tutoring Program*. Georgia School Counselors Association. *16* (1), 20-30. Retrieved from: https://files.eric.ed.gov/fulltext/EJ871911.pdf&ved=2ahUKEwjivM3lnbLfAhUFLI8KHeDQCO4QFjACe.

Joaquin, M. B. (2012, November). *Cogenerative peer teaching: Effects on students problem-solving skills and self-efficacy in mathematics.* Paper presented at the 5th International Conference of Education, Research and Innovation. Retrieved from https://library.iated.org/view/BELTRANJOAQUIN2012COG.

Kolahi S. & Safari L. (2014). The effect of alternative-teaching model on EFL learners' grammar achievement. *Modern Journal of Language Teaching Methods, 4*(4).

Madhar, I. (2013). *The effect of adult peer teaching in an English-as-a-second-language classroom*. (Master's Thesis). Available from ProQuest Dissertations and Theses Database. (UMI: 1527567).

Maples, J. B. (2009). *An analysis of the effects of class size on student achievement in selected middle schools in the Sandhills region of North Carolina* (Ph. D. Dissertation). Available from ProQuest Dissertations and Theses Database. (UMI: 3403569).

Mathis, W. J. (2016, June). *The Effectiveness of Class Size Reduction.* Retrieved from: http://nepc.colorado.edu/publication/research-based-options.

McDuffie, K.A., Mastropieri, M.A., & Scruggs, T.E. (2009). Differential effects of peer tutoring in co-taught and non-co-taught classes: Results for content learning and student-teacher interactions. *Exceptional Children*, 75(4).

NCTM. (2014). *National Council of Teachers of Mathematics*, Retrieved July 1, 2015, from http://www.nctm.org/Stan-

dards-and-positions/Position-Statements/Procedural-Fluency-in-Mathematics/.

Pazzibugan, D. Z. (2013). *DepEd scrambles to fill 61,510 teacher vacancies*. Retrieved June 30, 2016, from INQUIRER.net: newsinfo.inquirer.net/412211/deped-scrambles-to-fill-61510-teaher-vacancies/amp.

Portugal, M. R. B. (2014). *Multiple model approach: Effects on student conceptual and procedural understanding of fractions*. (Unpublished Masteral Thesis) University of the Philippines-Diliman, Quezon City, Philippines.

SEI_DOST & MATHED, Inc. (2011). *Mathematics Framework for Philippines Basic Education* [PDF file]. Retrieved from http://www.sei.dost.gov.ph/images/downloads/publ/sei_mathbasic.pdf.

Sileo, J. M. & van Garderen, D. (2010) Creating Optimal Opportunities to Learn Mathematics: Blending Co-Teaching Structures With Research-Based Practices. *Teaching Exceptional Children*, *42*(3).

Stacey, S. T., Cartwright, C., Arwood, Z., Canfield, J. P., & Kloos, H. (2017). Adressing the math-practice gap in elementary school: Are tablets a feasible tool for informal math practice? *Frontiers in Psychology, 8*(179) https://doi.org/10.3389/fpsyg.2017.00179.

Sullivan P. (2011). Teaching mathematics: using research-informed strategies. *Australian Council for Educational Research*, 59.

Systma, M. R. (2014). *Effects of a cross-age peer tutoring intervention on English language oral reading fluency in a Belizean grade school* (Ph.D. Dissertation). Retrieved from ProQuest Dissertations and Theses Database. (UMI: 3621995).