

Indoor-Outdoor Bodily Kinesthetic Teaching Technique and Manipulative with Student-Student Discourse: Effects on Students' Achievement and Retention in Plane Trigonometry

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ABSTRACT

The study investigated the effects of indoor-outdoor bodily kinesthetic teaching technique on students' achievement and retention in Plane Trigonometry. It was conducted at Misamis Oriental General Comprehensive High School, Cagayan de Oro City. Four intact sections from heterogeneous classes were randomly chosen as the participants of the study. Two sections were assigned as control groups. The control groups were exposed to manipulative and student-students discourse which is recommended by some researchers as good teaching strategies. The manipulative used for the control group was trigo-clock. For the experimental group, two sections were assigned. The experimental group was exposed to indoor-outdoor games such as trigo-card, trigo-trip, human-trigo sungka, and treasure hunting. The study used Pretest-posttest quasi-experimental control group design. The participants were given pretest before the treatment, posttest after the treatment, and retention test two weeks after the posttest, using the 25 items teacher-made achievement test. The teacher-made test has a reliability coefficient of 0.83. The data collected were analyzed using

mean, standard deviation, and analysis of covariance. Results of the analysis revealed that the achievement and retention scores of the students exposed to indoor-outdoor bodily kinesthetic teaching technique were as good as those students exposed to student-student discourse and manipulative. The researchers concluded that indoor-outdoor bodily kinesthetic teaching technique is a good teaching technique. The indoor-outdoor bodily kinesthetic teaching technique is recommended to be used by the teachers in mathematics as alternative teaching strategy to help increase students' achievement and retention scores in Trigonometry.

Keyword: Kinesthetic teaching technique, achievement, retention

INTRODUCTION

Higher mathematics achievements are the aim of all academic institutions for global competitiveness. However, 21st century learners have diversified learning style. They do not engage in the learning process if the teachers use a pure lecture method. It calls for the teachers to have varied teaching strategies that can make teaching-learning process productive and meaningful.

Trigonometry is one of the subjects which students have difficulty. The mathematical concepts in trigonometry are introduced through lecture method with the aid of calculators, and protractors. In the case where scientific calculator is not available, the trigonometric table is used. Most often, students' activities consist of purely answering the problems taken from books which may not motivate them to engage further. The students have minimal understanding of the concepts as manifested in their periodic achievement test as well as the National Achievement Test result.

Taclar (2013) introduced games in teaching Geometry and conducted a study on the effect of the method. In his study, he found out that achievement scores of the students who were exposed to mathematical games strategy were higher compared to the scores of the students taught using the chalk and talk method. He recommends the use of mathematical games strategy in presenting and discussing lessons in mathematics

Discourse is necessary to the learning process of the students to convey their ideas clearly. Sanchez (2013) stated that reasoning and sense making is the heart of mathematics. Learning situations that encourage discussion among students with the

proper supervision of teacher are necessary for conceptualizing meanings and understanding of concepts to be constructed.

Pagon and Polizon (2013) in their study about discourse in their mathematics class revealed that discourse among students and teachers was an effective strategy to stir the thinking of the students. Also, the researchers reported that discourse motivated the students to participate in the class discussions which leads to the understanding of mathematical concepts that were introduced. The researchers concluded that students exposed to discourse strategy of teaching obtained a higher achievement level in mathematics.

In this view, the researcher conducted a pretest-posttest quasi-experimental study which made use of indoor-outdoor bodily kinesthetic teaching technique and student-student discourse with manipulative to determine its effect on the students' achievement and retention scores in Trigonometry.

FRAMEWORK

This study leans on several theories of learning and results of some researches in which the design of the previous and present educational system have been considered. Gardner (1985) in his theory of multiple intelligence, stated that students have different learning styles. Some are bodily-kinesthetic where the students best learn through physical activities like movement, making things, or hands-on learning. Others are inclined towards interpersonal relations through interaction with peers by having group activities and any other related activities. In this study, researchers introduced varied activities to address the different learning needs of the learners. The participants in the experimental group were given outdoor games such as treasure hunting and human trigo sungka. A teacher-innovated trigo-card game was introduced also for the indoor game. For the control group, manipulative such as trigo-clock was used for the students to personally involved themselves in the hands-on activities. The leader of the group was the incharge to guide the students on how to use the manipulative. He acted also as facilitator for the student-student discourse during the class discussions.

The theory of Dewey (1925) in learning by doing emphasized that the best way to make the students learn is by direct personal experience. Learners should be personally involved and engaged the activities to achieve the desired learning outcome. By making the students involved in the activities, students were gradually develop and understand the mathematical concepts that used in the activities which the present

study is applied. Vygotsky (1978) in his theory about Zone of Proximal Development (ZPD), emphasized that the best way to develop the cognitive skills of the students is by interaction with peers who are knowledgeable in the subject matter. The theory suggested that cooperative learning exercises helped improved the less competent students within the zone of proximal development, with the help of the skillful peers. Based on Vygotsky's theory, group activities given in this study were led by the mathematically inclined students who mentor the members. The mentor acted as facilitator of the discussions before and after the activities.

Manipulative model and kinesthetic activities

Agot (2012), in his study on Manipulative model and Mathematics achievement in elementary Algebra, revealed that the use of manipulative teaching mathematics was effective. The hands on activities of the students using the manipulative help the students to recall the mathematical concepts and processes which contributed to a higher achievement level.

Mamaclay (2008), in her study on the effect of Math trail and hands-on activity, revealed that the performance and retention rate of the students had improved after the exposure in the activities. The students were active and enjoyed the experiences during the math trail activities which made them internalized the mathematical concepts applied in the trail.

In this study, Trigo-cards and trigo-clock were used as manipulative. The trigo cards composed of 32 pieces of playing cards with two different colors. Each color has 16 cards, having degree measure of angles multiples of 30° and 45° , while the other color has a radian measure of angles multiples of $\frac{\pi}{6}$ and $\frac{\pi}{4}$. The cards were used in playing the Trigo-card game. The game was played by two players who took turned of showing the cards.

Simpon (2011) stated that game is a good motivation to the students in teaching Mathematics for promoting healthy competition. Games in mathematics can stir the imagination and thinking of the students. Through mathematical games students can be critical and logical thinkers.

Griss (2013) believed that kinesthetic learning constructs memories connected to time, place and emotions, which are called episodic encoding. The students activate and integrate physical, emotional and cognitive responses to what they are learning, making it more meaningful. Some articles of the National Council for Teachers in Mathematics introduce kinesthetic activities in teaching mathematics. Tu (2012), in

his article: A kinesthetic approach to horizontal shift, suggested a kinesthetic activity for the students inside the classroom that facilitates the understanding of a horizontal shift. He introduced an activity that required the students to walk in one big xy-plane drawn on the floor and locate the point assigned to him which coordinates are written on her back. The activity motivated the students to learn the concepts in Plane Trigonometry.

Further, Touval (2013) in her article: Teaching the perpendicular bisector: A kinesthetic approach, stated that the kinesthetic approach of teaching has numerous pedagogical advantages and can be adapted to the teaching of mathematics. She said that the students exposed to the activity remembered the lessons throughout the year.

Bodily Kinesthetic activities used in this study are the activities which involve the movement of any parts of the body or the whole body, like dancing, walking, running, and some other related activities such Trigo-sungka, trigo-trip and treasure hunting. Treasure hunting was a group activity where the students used compass and meter-stick to locate the treasure following the given instructions .

OBJECTIVES OF THE STUDY

In many research studies, the use of manipulatives with discourse was found to have a positive effect on the students achievement scores, particularly in mathematics. This study aimed to compare the two methods of teaching namely: indoor-outdoor kinesthetic activities and manipulative with student-student discourse by determining its effects on students' achievement and retention scores in Trigonometry .

METHODS

Four sections were randomly selected and assigned as control and experimental groups. Every experimental and control group had 26 students who were further grouped by five and six for the group activities. At the start of the regular classes, the experimental and control groups were given orientations on how the class would be recited. For the experimental groups, lectures were given every Monday and Tuesday covering the topics for the week based on the Department of Education National Competencies. After the lectures, the teacher gave instruction to the students on what materials to bring for the activities. Wednesdays, the students had their group activities outside the classroom appropriate to the topics. Thursdays, similar activity was done by pair so that students had the opportunity to play and master

the game. The activities that were done outside and inside the classroom were the kinesthetic games and cards games depending on what games that fit to the lesson. Score sheet was given to them for every activity so that they can record their answers. The scores in the activities served as their quizzes to be used in giving grades but not included in the analysis of the data. Fridays, students were asked to write their reflections about how the activities helped them understand the mathematics concepts introduced, what they learned, what they did not learn and what they felt about the activities.

Meanwhile, the control groups had their class inside the classroom and were given activities that could enhance learning by using board works, seat works, oral recitations, student-student discourse using manipulative and doing assignments by group and then by individual. From Monday to Wednesday, they were given lecture discussions on the lessons such as definition of mathematical terms, introduction of mathematical concepts, and processes, covering the competencies for the week. During the first 15-20 minutes, everyday students had oral recitation and board works on the past lessons. Everybody was encouraged to participate in the activities during and after the discussions. Thursdays, the student-student discourse of the previous lessons was done by pair. Fridays, students were given a weekly quiz.

For the duration of the treatment, two mathematics teachers were asked to observe and to give comments on the activities following a check list on what to observe. The comments were compiled for the improvement of the study and were included in the Appendix section of this study. The scores of the students during the pretest, posttest and retention test were analyzed using Mean, Standard Deviation and ANCOVA.

RESULTS AND DISCUSSION

The stock knowledge of the participants in trigonometry and the comparability of the experimental and control group were determined through a pretest. The increment of the scores as an effect of the intervention was determined by comparing the mean of pretest and posttest scores.

Table 1

Mean and Standard Deviation of students' Mathematics Achievement Test Results

	Mean	SD	Total
Experimental group			52
Pretest	4.73	2.48	
Posttest	8.92	3.53	
Control group			52
Pretest	4.39	2.23	
Posttest	9.96	4.36	

Table 1 shows the mean and standard deviation of the control and experimental groups in the mathematics achievement test. In the pretest, the experimental group had a mean higher than the control group however, the mean difference was less than one. The value indicated that the experimental and control groups were comparable in terms of background knowledge in Trigonometry.

As to the variability of the pretest, the standard deviation of the experimental groups was higher than the control groups by 0.25. The result indicated that the scores of the students in both experimental and control groups have a similar dispersion because the difference of their standard deviation was less than one.

In the posttest, the control groups obtained a higher mean compared to the experimental groups. It has a difference of 1.04. It means that the students who were exposed to manipulative such as the teacher- made trigo-clock with student-student discourse have better achievement scores compared to the students exposed to indoor activities such as teacher-made trigo-cards and outdoor bodily kinesthetic activities such as trigo-trip, human trigo-sungka and treasure hunting. The result may be attributed to the learning style of the students who were not kinesthetic yet made involved in the kinesthetic activities because of all experimental group were involved in both indoor and outdoor activities. Furthermore, students who were exposed to lecture method in the class with a proper facilitated student-student discourse and manipulative activities had understood more concepts than playing outdoor. The

result can be interpreted that when students are given the opportunity to convey their ideas and express their opinion freely gradually understand the concepts. The result supports the findings of Agot (2012), Polizon and Pagon (2013) which revealed that manipulative and students discourse had an influence on the student’s achievement scores in mathematics.

As to the variability of the achievement scores in the posttest, the standard deviation of the control groups was larger than the experimental groups. The result indicated that the scores of the students who were exposed to manipulative and student-student discourse were more dispersed compared to the students who were exposed to indoor –outdoor bodily kinesthetic teaching technique. It also means that the students in the control groups had a varied learning absorption while in the experimental groups had almost the same absorption of the mathematical concepts after the treatment. Further, Analysis of Covariance (ANCOVA) was used to determine if the treatment had a significant effect on the students’ achievement .

Table 2

Summary table of ANCOVA in the Mathematics Achievement test results

Source of Variation	DF	AdjSS [*]	AdjMS [*]	P- value
Methods of teaching	1	17.14	17.14	0.23
Error within	103	1432.18	15.08	
Total	104	1449.32		

*Significant at $p < 0.05$ alpha level

Table 2 showed the analysis of covariance of the achievement scores in Trigonometry. The analysis yielded a computed P-value of 0.23 which was greater than 0.05 level of significance. The result allows the researcher not to reject the null hypothesis that there is no significant difference on the achievement scores of the students in Trigonometry as influenced by the two methods of teaching. It means that the performance of the students who were exposed to manipulative like Trigo-clock with student–student discourse was statistically comparable to the performance of the students who were exposed to indoor-outdoor bodily-kinesthetic teaching technique. This implies that the two methods of teaching used in this study

have the same influences on the students' achievements scores in mathematics. This implies further that using bodily kinesthetic teaching technique in class was as good as using manipulative and student-student discourse which was proven effective by Mamaclay (2008), Agot (2012), Polizon (2013), and Pagon (2013) in their research study.

Table 3

<i>Mean and Standard Deviation of students' retention scores in Trigonometry</i>			
	Mean	SD	Mean Difference
Experimental Group			
Posttest	8.92	3.53	1.41
Retention Test	10.33	3.93	
Control Group			
Posttest	9.96	4.36	1.82
Retention test	11.78	4.72	

Table 3 showed the mean and standard deviation of the students' retention scores in Trigonometry. The mean differences of experimental groups in posttest and retention test were 1.41 while the control groups were 1.82. This means that even if the students were not in the actual discussions of the concepts, the past lessons that they had discussed using the two different methods were still in their minds. In fact, they continue to explore the concepts as manifested in the increase of the scores in the test given two weeks after the posttest.

As to the difference of the retention mean scores, the control group was higher by 1.45 compared to the experimental group. This means that the students who were exposed to manipulative and student-students discourse may have better retention of mathematical concepts than the students who were exposed to indoor-outdoor activities. This may also mean that the use of manipulative such as a teacher made trigo-clock with student-student discourse allowed students to remember more concepts compared to the indoor-outdoor kinesthetic teaching technique.

Furthermore, students exposed to manipulative with student-student discourse may have assimilated more concepts and principles in mathematics that were discussed. The result conformed with the theory of Dewey on learning by doing of where the students best learn through personal experiences.

As to the variability of the scores, the standard deviation of the experimental and control groups was quite large which means that scores of the students in retention test in both group were all widely dispersed. However, the standard deviation of the retention test scores has a difference of 0.79 in favor of the control groups which implied that the scores of the students in the control groups were quite spread compared to the cores of the students in the experimental. This implied further that the students in the control groups had a different level of retention of the knowledge discussed compared to the level of retention of the students in the experimental group. This can be interpreted further that the students exposed in the manipulative and student-student discourse had different absorption and internalization of concepts taught while students who were exposed teacher made trigo-card games, treasure hunting, human trigo-sungka, and dancing around the unit circle, had a quite similar absorption and internalization of concepts. To determine if the treatment had significant effect on the retention score ANCOVA was used.

Table 4

Summary table of ANCOVA of the Mathematics Retention test results

Source of Variation	DF	AdjSS'	AdjMS'	P- value
Methods of Teachings	1	15.84	15.84	0.7
Error within	102	1264.74	13.31	
Total	103	1280.58		

*Significant at $p < 0.05$ alpha level

Table 4 shows the results of the analysis of covariance of the retention test scores in Trigonometry. The analysis yielded a computed P-value of 0.7 greater than 0.05 level of significance. This allowed the researcher not to reject the null hypothesis that there is no significant difference of the retention scores of the students in Trigonometry as influenced by methods of teaching. This means that the retention score of the students who were exposed to manipulative like Trigo-clock with student

–student discourse is comparable to the retention of the students who were exposed to indoor-outdoor bodily kinesthetic teaching technique. This implies that the two methods of teaching used in this study had the same effect on the students' retention score. This implies further that using indoor-outdoor bodily kinesthetic teaching technique in the class was as good as using manipulative and student-student discourse. This means that the two methods of teaching can be alternately used for the teachers to have a variety of teaching strategies.

CONCLUSIONS

Based on the findings of the study, the researcher concluded that indoor–outdoor bodily-kinesthetic teaching technique has a positive effect on students' achievement and retention scores in Trigonometry and can be used as an alternative teaching strategy.

RECOMMENDATIONS

Based on the findings and conclusions, the following recommendations are given:

1. Mathematics teachers may use indoor-outdoor bodily kinesthetic teaching technique to improve the achievement and retention scores of the students in Trigonometry; and
2. Further research is recommended using wider scope.

LITERATURE CITED

- Agot, M . V. (2012). *Manipulative model and Mathematics achievement in elementary Algebra*. Theses. MUST
- Dewey, J. (1925). *Theory of learning*. Volume1. 1925.....books:gooogle.com
>Philosophy> history and Durveys>Modern. <https://www.google.com.ph>.
- Gardner, H. (1985). *Educational Leadership: Teaching Multiple Intelligences*.
www.asid.org/.../ The first—Seven---- and – the --- Eight @
<https://www.google.com.ph>.Sept. 1997/Vol. 55/no. 1 by Kathy Chekley

- Griss, S. (2013). *Mnds in Motion: A kinesthetic Approach to teaching*.
www.amazon.com>.....> Education Theory .
- Mamaclay, A. (2008). *Math trail and hands-on: two learning activities and their effects on mathematics performance of selected high school students*. MUST.
- Pagon, R.(2013). *Student-student discourse on selected topics in algebra: Its effects to students achievement and mathematics anxiety*. Mindanao University of Science and Technology.
- Polizon,M. (2013). *Mathematics discourse and journal writing: Their impact on students' mathematics performance*. Mindanao University of Science and Technology.
- Rondina, J, et. al. (2018). Strengthening the Students' Achievement and Reducing Anxiety in Mathematics Through Kinesthetic Teaching Technique. *Science International*. (Lahore) Vol.30, no.3
- Simpson, A. (2011). Mathopoly, assessment, engagement, fun. *Mathematics Teachers*. Volume106, No. 6, 2013.
- Taclay, R. (2013). Effects of Mathematical Games Strategy on the Achievement of Students in High School Geometry. *International Journal of Scientific & Engineering Research*, 5(6). June-2014 678. ISSN 2229-5518
- Touval, A. (2013). Teaching the perpendicular bisector; A kinesthetic approach. Article. *NCTM*, 105.
- Tu, W. (2012). A kinesthetic approach to horizontal shift.Article. *NCTM*, 105(7).
- Vygotsky, L. (1978). *Interaction between learning and development*.
www.psy.cmu.edu/siegler/vygotsky 78. [https/ google .com.ph](https://google.com.ph).
- Vygotsky, L.S. (1978). *Mind in society*. Cambridge, MA: Harvard University Press
[https/google.com.ph](https://google.com.ph).

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