Teaching Approaches to Minimize Students' Anxiety and Attitudes in Mathematics

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Abstract

This quasi-experimental study aimed to discover a teaching approach in Mathematics that can minimize the students' Mathematics anxiety and turn the students' apprehensions into positive attitudes toward Mathematics. The study was conducted at Misamis Oriental General Comprehensive High School, with 104 grade 10 students who belong to the regular section serving as the respondents. There were 52 students randomly assigned to the control and experimental groups who were exposed to manipulatives with student-student discourse and to a kinesthetic teaching approach, respectively. In both control and experimental groups, 26 students were assigned in groups with reward, and 26 were assigned in groups without reward during the conduct of the activities. Pretest and posttest of the Mathematics Anxiety Self-test and Mathematics Attitude Test were given to both groups before and after the treatment. The result of the study revealed that a kinesthetic teaching approach and teaching using manipulatives with student-student discourse have the same effect on students' attitudes toward Mathematics. Both the control and experimental groups of students have a moderately positive attitude towards Mathematics after the intervention. Regarding to Mathematics anxiety levels, the study revealed a significant difference in favor of the experimental group. Students exposed to a kinesthetic teaching approach have a lesser Mathematics anxiety level. Hence, the researcher recommends using a kinesthetic teaching approach to minimize the Mathematics anxiety of the students and to turn their negative attitude toward Mathematics into something moderately positive.

Keywords*: anxiety, attitude, Mathematics, quasi-experimental, ANCOVA, kinesthetic, discourse, reward, Philippines*

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1.0 Introduction

"Behind Great Mathematics Students are Great Mathematics Teachers," NCTM President Lott (2003) stated. He further said that a well-prepared teacher is important to a child's education. It was supported by Dela Rita (2011), who said that students' achievement is the teachers' primordial responsibility and accountability. However, Martinez (1987) stated that anxiety might be a greater barrier to mathematics learning than supposed deficiencies in school curricula or teacher preparation. The developers of MARS (Math Anxiety Rating Scale) said that anxiety involves feelings of tension and interferes with manipulating numbers and solving mathematical problems.

A lot of studies have revealed that mathematics anxiety affects students' performance. Educators, in this regard, have continued looking for a method of teaching that can minimize Mathematics anxiety. Pagon (2013) used student-student discourse in teaching Algebra and studied its effect. His study revealed that teaching mathematics using student-student discourse minimizes Mathematics anxiety. He further cited that using such a method allowed the students to convey their ideas to their classmates without worrying about committing mistakes. Talking about mathematics without hesitation leads to fruitful discussions, which eventually lead to a deeper understanding of the mathematics concepts being discussed.

In psychology and education, Illeris (2000) stated that a common notion of learning is a process that brings together cognitive, emotional, and environmental influences and experiences for acquiring, enhancing, and making changes in one's knowledge, skills, values, and world views. Different learning theories help educational psychologists understand, predict, and control human behavior. According to the operant conditioning theory, Thorndike (1905) and Skinner (1950) as cited by McLeod, S. A. (2017), believed that reward shapes and maintains the desired behavior. Students' disruptive behavior may be corrected by giving a reward. A reward can provide both extrinsic and intrinsic motivation to perform a task.

Pavlov's theory of classical conditioning, believed that behavior could be modified through a process of association wherein two stimuli can be linked together to produce new responses ("Classical Conditioning (Pavlov)", 2013). In the learning process, rewards may be used as motivation for the students to work hard, resulting in high achievement. Rewards are reasons for individuals to perform well in a given situation. The reward system motivates professionals to work hard for better performance. Kirunda (2004) stated that Performance-Based Rewards (PBR) affected the performance of teachers in different ways, and it was realized that PBR motivated teachers: it increased their performance, and improved their productivity and efficiency. What is true for teachers may also be true for students, especially in mathematics, which is a complex subject. Cameron (2001) suggested that rewards can be arranged to progressively shape performance, cultivate interest in an activity, build skills, and maintain effort and persistence at a task. Rewards motivate students to work hard for success. However, Deci et al. (2001) claimed a serious reason to be concerned about how teachers reward students. They claimed that using rewards as a motivational strategy is a risky proposition and that educators need to focus more on educational practices that support students' interests and nurture the development of self-regulation.

Heider (1958), in his theory about attitude change, as mentioned by McLeod (2018), stated that when beliefs are unbalanced, stress is created, and there is pressure to change attitudes. This theory is very much applicable to the learning process of students. In this case, when the teacher knows that the attitude of his students toward the subject is unbalanced, he should create a learning environment with a balanced atmosphere. As cited by McLeod (2018), Festinger (1957)theory of cognitive dissonance, stated that attitude change is caused by conflicting beliefs. This theory applies to the learning process of students. When the majority of the students have a positive attitude towards the subject, there is a possibility that other students will also be influenced to like the subject. This was supported by Abelson (1968) in his theory of Cognitive Consistency, which states that people will try to maintain consistency among their beliefs and only make changes when it does not occur. In this context, teachers can change the negative attitude of the students towards the subject into a positive attitude and sustain it by providing a stress-free and motivating learning environment where everybody has equal opportunities to establish one common goal of learning.

Kinesthetic activities may be given to the students in the form of games. Craig (2002) stated that games are an excellent motivational tool for students in teaching Mathematics. It allows students to build up their fundamental skills and have fun at the same time. Abu Bakar (2007) said that using games that involved outdoor events promoted mathematical thinking and learning, communicating, and doing mathematics while having fun in the process. Students' exposure to games pushed them towards communicating mathematics on their own, with the guidance of their teachers. By participating in the mathematical games, students' thinking process through bodily movement exhibits the

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what is happening with reflection on the effect of their actions not only gives meaning to the concepts but also helps construct ideas in the learners' minds. Simpson (2011) also mentioned in the Readers' Reflection section of the Nat'l Council of Teachers of Mathematics (2013) proceedings that games are motivational tools, especially for at-risk students, and promotes healthy competition. On the other hand, giving rewards may also be used during the learning activities to motivate students' participation, thus improving their achievement. Leuven and Oosterbeek (2010) conducted a study on the effect of giving a cash reward to students. Their study revealed that financial incentives have positive impacts on the achievement of students with high ability, while adverse impact on the achievement of low-ability students.

On the other hand, discourse is necessary for the learning process for the students to convey their ideas. Booker (2007) said that achieving meaningful learning is obtained through a classroom community with teacher–student discourse. Sanchez (2013) claimed that learning situations that encourage discussion among students with teachers are necessary for conceptualizing meanings and understanding of concepts to be constructed. The researcher theorized that when the students can fully understand the mathematical concepts introduced by the teachers, their self-confidence will boost. Consequently, this may result in a decrease in mathematics anxiety and turn the negative attitudes towards mathematics into positive ones and vice versa. Hence, this study was conducted to verify whether the kinesthetic teaching approach with a reward system in Mathematics has an effect on students' attitudes and anxiety towards the subject.

2.0 Research Methodology

This study used a pretest-posttest quasi-experimental-control group design to determine the effect of the indoor-outdoor kinesthetic teaching approach on students' attitudes and anxiety in Mathematics. Four intact sections from the grade 10 regular class of students at Misamis Oriental General Comprehensive High School (MOGCHS) were randomly chosen and used in this study. Two of which were randomly assigned as control groups exposed to the conventional approach, which was manipulative with student-student discourse, and the other two groups were the experimental groups that were exposed to the indoor-outdoor kinesthetic teaching approach. One section from the control and one section from the experimental group were randomly assigned a reward in the form of additional points and candies when they performed well in the activity. On the other hand, the remaining two sections from the control and experimental groups performed the activities without reward.

The study used the 21-item Aiken's Mathematics Attitude Scale with a reliability coefficient of 0.85 and the 14-item Freedman's Mathematics Anxiety Self-Test with a reliability coefficient of 0.64. The tests were given to the participants before and after the treatment was introduced. Copies of the test questionnaires are attached in the appendices.

For ethical consideration, the researcher asked permission from the Mathematics Department Head and the School Principal of MOGCHS. Also, the researcher assumed that students participated in the activities freely and answered all the questions in the instruments of the study honestly because they did not know that they were under study.

For the experimental groups, lectures were given every Monday and Tuesday, covering the topics stipulated in the learning guide for teachers. After the lectures, the teacher gave instructions to the students on what materials to bring for the activities. During Wednesdays, the students had their group activities outside the classroom appropriate to the topics. Parallel activities were given on Thursday and Friday, but they were done by pairs or individuals. Regarding the rewards, the teacher announced the winners, and a reward was given at the end of every activity. The results of the activities and the game scores were recorded for their grades but

For the control groups, a conventional approach was implemented. Activities that can enhance learning, such as board works, seat works, oral recitations, and student-to-student discourse using manipulatives, were given. From Monday to Wednesday, they were given lectures on mathematical concepts. For the first 15-20 minutes every day, students had oral recitation and board work on the past lessons. The whole class was encouraged to participate in the activities during and after the discussions. On Thursdays, the student-student discourse was done by pair, and on Fridays, they did the weekly quiz. About the rewards, the teacher announced the winners and then gave the reward. The scores on the short and long tests were recorded for their grades but not included in the data analysis.

After covering the desired topics, a posttest was given to both experimental and control groups on the same day. The posttest in mathematics attitude and anxiety was given. The collected data were analyzed using mean, standard deviation, and two-way ANCOVA. The pretest served as a covariate, while the posttest served as a criterion measure.

3.0 Results and Discussion

Table 1. Mean and Standard Deviation of Mathematics Attitudes' Scale

		Experimental Group		**Control Group**		Row Scores	
		Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
With Reward	Mean	4.00	4.17	4.05	3.86	4.02	4.01
	Sd	0.46	0.42	0.29	0.36	0.39	0.42
	n	26		26		52	
Without Reward	Mean	4.01	4.09	4.16	4.12	4.09	4.11
	Sd	0.3	0.34	0.34	0.44	0.33	0.40
	n	26		26		52	
Column Scores	Mean	4.01	4.13	4.09	4.12		
	Sd	0.39	0.39	0.32	0.42		
	N	52		52		104	

The table shows the mean and standard deviation of students' scores on the Mathematics Attitudes Scale test. In the pretest, the mean of the control groups was higher than the mean of the experimental groups by 0.08. However, the results were reversed during the posttest. The mean of the experimental groups became higher than the mean of the control groups by 0.01. Pretest and posttest results lie within the interval of having a moderately positive attitude towards mathematics. Although there were changes in values, they were minimal. The attitude of the students under study towards mathematics is moderately positive.

Regarding the reward system, the mean score of the groups without reward is higher than the groups with reward by 0.07 during pretest. The result is consistent during the posttest. The difference turned to 0.10. During pretest and posttest, it can be observed that both groups have almost the same attitude towards mathematics. All groups lie within the same interval at 3.50–4.49, which indicates an agreement of having a moderately positive attitude towards mathematics before and after the treatment.

As to the variability of the responses in the pretest, the control and experimental groups with and without reward have a standard deviation of less than one. This means that the students' responses are uniform, which implies that all groups have a homogeneous attitude towards mathematics. Furthermore, this implies that the majority of the students in both groups had a moderately positive attitude towards mathematics before and after the treatment. A minimal difference in the mean score between both groups was observed. Further analysis is done to determine a significant difference. An Analysis of Covariance (ANCOVA) was used.

Table 2. Summary table of two factors ANCOVA of the Mathematics Attitude Scale

Source of Variation	df	SS'	MS'	Computed F-ratio	Probability Value
Factor A: Reward	1	0.11	0.11	0.90	0.35
Factor B: Treatment	1	0.11	0.11	0.90	0.35
Interaction AB	1	0.01	0.01	0.05	0.82
Error Within	95	11.57	0.12		
Total	98	11.8			

Table 2 shows the result of the analysis of covariance of the Mathematics Attitude Scale. The analysis revealed that for Factor A, which is about the rewards system, yielded a computed F-ratio of 0.9 with a probability value of 0.35. This ratio is greater than the critical value at the 0.05 level of significance. The result led the researcher not to reject the null hypothesis that there was no significant difference in the mathematics attitude of the students as influenced by the reward system. This means that the reward system did influence the attitude of the students towards mathematics. Furthermore, students who were given the reward and those who were not given a reward have the same moderately positive attitude towards Mathematics. The findings further imply that candies, chocolates, and extra points are not the reasons for the students' increased interest in Mathematics. This means that extrinsic motivation of less value is not attractive to students of adolescent age. The result conforms to the study by Leuven and Oosterbeek (2010) which revealed that financial incentives turn out to have positive effects on the achievement of high-ability students and negative effects on the achievement of low-ability students. When the findings of this study are combined with the findings of the previously mentioned study, the researcher can conclude that rewards in any form did not motivate students in regular sections to perform better in mathematics.

For factor B, on the teaching methods, the analysis yielded a computed F-ratio of 0.90 with a probability value of 0.35, which is greater than the critical value at the 0.05 level of significance. This led to the non-rejection of the null hypothesis that there is no significant difference in students' attitudes towards mathematics as influenced by teaching methods. This means that students' attitudes towards Mathematics who were exposed to manipulatives with student-student discourse are comparable to those exposed to kinesthetic activities. This implies that students' attitudes towards mathematics in the experimental group are identical to those in the control group. Furthermore, there was no interaction of students' attitudes toward Mathematics in terms of the methods of teaching and reward system. With regard to interaction, the analysis also yielded an F–ratio that is greater than the critical value at the 0.05 level of significance. This led the researcher not to reject the null hypothesis that there is no significant interaction of the students' attitudes toward Mathematics as influenced by the methods of teaching and reward system. This implies that teaching methods and reward systems have no mixed effects on the students' attitude toward Mathematics. Students who were exposed to kinesthetic teaching techniques and reward systems have the same favorable attitude towards mathematics as students who were exposed to manipulative and student-student discourse and reward systems.

Table 3. Mean and Standard Deviation of the Mathematics Anxiety Test

	Experimental Group		**Control Group**		Row Scores	
	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
Mean	2.83	2.45	3.1	2.87	2.69	2.66
Sd	0.65	0.58	0.77	0.69	0.73	0.67
n	26		26		52	
Mean	3.14	2.74	3.05	2.88	3.1	2.81
Sd	0.59	0.57	0.62	0.67	0.61	.63
n	26		26		52	
Mean	2.99	2.6	3.08	2.88		
Sd	0.64	0.59	0.71	0.68		
N	52		52		104	

Table 3 shows the mean and standard deviation of students' Mathematics Anxiety self-test.

Regarding the reward system, the difference between the mean of the students with reward and those without reward in the pretest is 0.14, indicating that the groups without reward are more anxious. In addition, the mean values of both groups belong to the descriptive level, which is undecided. This means that all students' responses to the questionnaire were undecided regarding their feelings and emotions toward Mathematics at the start of the study. However, in the posttest, the result is reversed. The mean score of the mathematics anxiety self-test of the students with and without rewards has a difference of 0.15, signifying that the students with rewards are less anxious. This means that the students who received rewards had less anxiety towards mathematics and experienced a greater decrease in fear than those who did not receive rewards. It could imply that rewarding students may cause them to enjoy mathematics and reduce their fear. Meanwhile, the mean scores of the anxiety test for both groups belong to the interval level, which is still described as undecided.

As to the variability of the responses in the pretest, the groups with and without reward have a standard deviation of less than one. This means that the scores of the students in the mathematics anxiety self-test have similar dispersion. This means further that the anxiety of the students towards mathematics in groups with and without reward is comparable and belongs to the descriptive interval, which is undecided. In the posttest, concerning the variability of the reward system, the students exposed to rewards had a standard deviation higher than the students who did not receive rewards by 0.04. The difference is very minimal, which means that the students who did not receive a reward have a similar anxiety level towards Mathematics as the students who did receive a reward. In addition, the mathematics anxiety of the students in both groups with and without reward is homogeneous because their standard deviation is less than one.

As to the teaching methods in the pretest, the mean score of the experimental and control groups differs by 0.09. The students in the experimental and control groups had almost the same level of anxiety towards mathematics because the difference is very minimal. The data further shows that both groups belong to the descriptive interval, which is undecided. The students were initially filled with skepticism and fear of mathematics. However, in the posttest, the mean difference of the scores of the students in the mathematics anxiety self-test becomes 0.28, wherein the experimental groups show a significant decrease in mean score. This means that the students exposed to kinesthetic teaching techniques had decreased their fear of mathematics and were less anxious after the treatment than those exposed to manipulative and student-student discourse.

As to the variability of the responses, the control and experimental groups had a standard deviation of less than one in the pretest. This means that the dispersion of the students' scores on the mathematics anxiety self-test is similar. This means that the mathematics anxiety of the students is comparable and belongs to the descriptive interval, which is undecided. In the posttest, the groups exposed to kinesthetic activities had a more significant decrease in standard deviation. This means that the feelings of Mathematics Anxiety among students become less homogeneous as they are exposed to kinesthetic activities. The Two-way ANCOVA was used to determine a significant effect of the methods of teaching and reward system on the student's mathematics anxiety.

Table 4. Summary Table of the Mathematics Anxiety Self-test Results - **ANCOVA**

Source of Variation	df	SS'	MS'	Computed F-ratio	Probability Value
Factor A: Reward System	1	0.130	0.130	0.52	0.47
Factor B: Method of Teaching	1	1.23	1.23	4.96*	0.028*
Interaction AB	1	0.023	0.023	0.09	0.76
Error Within	95	23.55	0.25		
Total	98	24.93			

*Significant at 0.05 level

Table 4 shows the result of the analysis of covariance of the mathematics anxiety self-test scores.

For the rewards system, the analysis yielded a computed F-ratio of 0.52 with a probability value of 0.47, greater than the critical value at the 0.05 level of significance. The results of the analysis revealed that there was not enough evidence to reject the null hypothesis. This suggests that the students without reward had the same level of anxiety about mathematics as those with reward. This result further implies that rewards like candies, chocolates, and giving extra points to the fourth-year students had no appeal to the decrease of the participants' fear of mathematics. With reward or without a reward have no effect on reducing fear of mathematics.

With regard to the methods of teaching, the analysis yielded a computed F-ratio of 4.96 with a probability value of 0.028, which is less than the critical value at the 0.05 level of significance, which allows the researcher to reject the null hypothesis that there is no significant difference in the mathematics anxiety of the students as influenced by the methods of teaching. This means that the mathematics anxiety of the students who were exposed to manipulatives, such as the Trigo-clock with student–student discourse have higher anxiety levels compared to those who were exposed to kinesthetic teaching techniques. This implies that using kinesthetics or games in the class influenced more significant reduction of anxiety than those students doing the lesson inside the class. This means further that kinesthetic activities as a teaching technique are an excellent method to reduce anxiety towards mathematics. This means that lessons done through games could reduce fear in mathematics.

As to the interaction of students' anxiety towards mathematics as influenced by the methods of teaching and reward system, the analysis yielded a computed F– ratio of 0.09 with a probability value of 0.76, which is greater than the critical value at the 0.05 level of significance. The result gives no sufficient evidence to reject the null hypothesis that there is no significant interaction between the mathematics anxiety of the students as influenced by the methods of teaching and the reward system. This means that the reward system and teaching methods did not have a mixed effect on the students' anxiety towards mathematics.

3.0 Conclusion

Based on the analysis of the data, the researcher concluded that the effect of kinesthetic teaching techniques and student–student discourse with manipulatives on students' attitudes towards mathematics had no significant difference. Both groups had a moderately positive attitude towards mathematics. On the students' Mathematics Anxiety self-test, a significant difference is found in favor of a kinesthetic teaching approach. The Mathematics anxiety level of the students towards mathematics decreased as they were exposed to kinesthetic teaching techniques compared to the control groups. On rewards, the system applied in the study did not have a significant effect on the Mathematics anxiety and attitude of the students. Students with and without rewards manifested the same anxiety and attitude levels in and toward mathematics.

4.0 Recommendations

The researcher recommends that teachers use a kinesthetic teaching approach to minimize the students' anxiety about Mathematics. Also, researchers may conduct a similar study, and use the kinesthetic teaching approach in other fields of Mathematics.

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