The Effect of Think-Pair-Share Cooperative Learning Model on Grade Twelve (12) learners' Performance in Quadratic Functions: A Case of Twashuka Secondary School in Luanshya

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Abstract:-**The problem of poor performance in Mathematics at Twashuka Secondary School remains a major concern. This study was designed to determine the effect of the Think Pair Share model of cooperative learning Approach on learners' performance in Quadratic Functions by adopting a quasi-experimental control group pre-test and post-test design. Two classes were randomly assigned to the experimental group and the control group. The sample size comprised of 42 learners (18 males and 24 females). The experimental group comprised of 19 leaners while the control group comprised of 23 learners. The study collected quantitative data from the participants. Achievement and Attitude tests were used to collect data regarding participants' engagement during the teaching and learning processes. The experimental group was taught using the Think-Pair-Share cooperative learning model while the control group was taught using conventional learning approach. Quantitative data was analysed by computing inferential (F tests and t-tests) and descriptive statistics (Means and Standard deviations) using the Statistical Package for the Social Sciences version (SPSS). The findings indicate a significant difference existed between the posttest scores of the experimental and control group $t(40) = 2.823$, $p< 0.001$. The mean score of the experimental group was higher ($M = 71.47$, $SD = 25.650$) than that of the control group ($M =51.61$, $SD = 19.965$). The study also found that learners have positive attitudes towards cooperative learning and mathematics ($Mdn = 3.45$).Further, an independent samples U test indicated that there was a significant difference between the mean attitude of males and females ($U = 77.500$, $p = 0.022$, $r = 0.512$), with a large effect size. These findings have implications for teaching and policy making. Teachers need to employ the think-pair-share model of cooperative learning in order to improve both learners' performance and attitudes towards Quadratic Functions. This may require teachers to be trained in the effective use of cooperative learning models through in-service training programs. Researchers need to conduct more action research studies to ascertain the effectiveness of these models in improving performance and attitudes towards mathematics.**

Key Words: **Think-Pair-Share Cooperative Learning Model, Quadratic Functions, Learners.**

I. BACKGROUND

Being a teacher of Mathematics at Twashuka Secondary, the researcher has observed that Quadratic Functions have been and are still giving a number of challenges to the grade 12 learners in tests as well as examinations. It has also been observed that whenever the grade 12 learners are writing a test where questions are optional, the majority of them do not attempt any question involving Quadratic Functions. And moreover, there is always a question on quadratic functions in the grade twelve final examinations every year. Education plays a pivotal role in maximizing individual's potentials and is a prerequisite for meaningful and sustained national economy. Even though the educationists had made efforts in improving teaching-learning processes, instructional designers are still searching and experimenting to get best methods for optimal academic performance of the students. This is because, in the traditional approach of teaching, most of the class time is spent by teachers talking and students watching and listening, and cooperative learning approaches appear to be discouraged. Similarly, Johnson et al. (2007) elucidated that, in individual learning, how the students perceive and interact with one another is a neglected aspect of instruction. Correspondingly, the knowledge of Mathematics contributes to scientific literacy and helps to understand the world in which we live. However, it is clear to state that Mathematics is foundational in many ways that informs our decisions in areas of our lives. Teaching and learning Mathematics is at the heart of education. Learning Mathematics aims to link school to everyday life, provide skill acquisition, prepare students for the workforce, and foster mathematical thinking (Ontario Ministry of Education, 2005). Mathematics involves learning to problem-solve, investigate, represent, and communicate mathematical concepts and ideas, and making connections to everyday life (Ontario Ministry of Education, 2005). In point of fact the learning of mathematics is not only oriented towards learners acquiring mathematics knowledge or meeting learning outcomes, instead, but it also needs to develop various other abilities that must be possessed by learners in the mathematical learning process. For example, learning mathematics should also develop 21st Century skills such as communication, creative skills (problem-solving), and collaboration skills among others. Improving the quality of learning will encourage learners to become more engaged and enjoy the learning process (Alim, Umam & Wijirahayu, 2016) hence the need for the implementation of approaches which enhances the performance of the learners in the national examinations which have been characterized to be poor in the recent years. In the past years, Twashuka secondary school has recorded lower pass percentages in Mathematics. For instance, in 2017, out of 140 candidates who sat for the grade 12 Mathematics final examinations, only 72 candidates representing 53.6% passed the examination while 68 candidates representing 46.4% failed. In 2016, the pass percentage was 31.6% while 69.4% of the learners failed the Mathematics final examination. The pass percentages for 2015, 2014 and 2013 were 21.5%, 37.4%, and 31.8% respectively. These poor grades in the subject may result in difficulties in progressing to the next level of studies, especially when certain mathematics skills are required to be implemented as part of the syllabus. Historical analysis of the patterns and trends in education reveal that, people live and work in a highly changing society whose existence and sustainability is dependent on mathematics. The increasing technological and industrial revolution in education, agricultural, health, and industrial growth marks one of the important milestones in history. While this has been used as a benchmark of development, it has gone a long way to define the economic power of many countries. Mathematics is increasingly viewed as a subject of life-long utility among students, society and the country at large. This has been reiterated by McIntosh (1994) who states that Mathematical literacy has become a necessity for everyone as the need to use scientific information to make choices that arise in everyday life increases. However, the students' learning performance and achievement in Mathematics at Twashuka Secondary School has been poor over recent years in tests and national Examinations.

II. RESEARCH METHODOLOGY

2. Overview of the Chapter

This chapter reviews the methods that were used to collect and analyse the data in during the research. It focuses on the research design, research site, target population, sample and sampling procedures, data collecting instrument/techniques/methods, reliability of data collection instrument, validity of data collecting instrument, data analysis techniques and scoring of questionnaire items.

2.1 Research Design

The study adopted quasi-experimental research with pretest-posttest counter-balanced design with the control group. Two groups were selected with one randomly assigned to the experimental group and the other to the control group. This was done so that both groups were exposed to the treatment at some stage of the study. The figure below summarises the research design.

Group	pretest		posttest
Experimental group	O_1	Think-pair-share CL	O_2
Control group	O_1	Traditional learning	O_2

Figure 1: Research Design

Where;

- $\boldsymbol{O_1}$: Pre-test was given to both the experimental and control group on quadratic functions.
- $\boldsymbol{O_2}$: Post-test. Both the experimental and the control groups were given a Post-Test after exposing the experimental group to the think-pair-share cooperative learning model. Then comparisons were made between pre-test and post-test performance within groups and between groups. The significant difference in performance in quadratic functions between the two groups was as the result of treatment (think-pair-share cooperative learning model).

2.2 Description of the study area

The study was conducted at Twashuka Secondary School, one of the secondary schools in Roan Township of Luanshya district on the Copperbelt province of Zambia.

2.3 Study population and Participants

The target population of the study was 120 learners. The sample size comprised of 60 learners 30 of which formed the experimental group while 30 learners formed the control group.

However, due to inconsistence on the part of the learners in terms of class attendance, there were variations on the number of learners participating in the study as 11 from the experimental group and 7 from the control group dropped out.

2.4 Access to Participants and Confidentiality

The participants were informed that the information that would be collected or generated by the study was strictly for academic purposes and for improving the teaching of mathematics at Twashuka secondary. They were further informed that participation in the study was strictly voluntary so that they would be free to choose whether or not to be part of the study. Consent forms were given to the participants before the commencement of the study. Further, permission to conduct the study at Twashuka secondary school was sought from the management.

2.5 Methods

This research was quantitative with a pretest-posttest counter-balanced control group quasi-experimental design. The research was conducted in two classes (groups) with the same characteristics. Firstly, the two groups were pre-tested on quadratic functions and the scores were recorded. Then the experimental group was taught using the Think-Pair-Share Cooperative Learning Model whereas the control group was taught using conventional learning methods. Both groups were pre and post-tested with the same instruments to measure their mathematical concepts on Quadratic functions. In addition, the experimental group was given an attitude questionnaire to measure their attitudes towards the Think-Pair-Share cooperative learning model after the treatment.

The instruments were made in open-ended so as to be able to measure not only the acquisition of mathematical concepts but also specific skills such as mathematical problem solving, information skills, communication, and creativity. Problem-solving items were developed through a series of daily life around learners' environments and they were instructed to think carefully inapplying appropriate mathematical concepts to solve given problems.

2.5.1 Experimental Group

In the experimental class, the researcher set the classroom for learners to sit in heterogeneous groups of 3 - 4. The teacher presented open-ended mathematics problems, and then the learners were asked to individually think about solving the problem. In their groups, learners discussed and thought about choosing relevant information and appropriate mathematical concepts to solve the problem. They then used such information to solve the given problem in their respective groups. After solving the mathematical problem in groups, each group was asked to present the outcome of the problem given using the media of their choice while other learners gave feedback to their friends' performances.

2.5.2 Control Group

The control group was taught the same material; however, the learning method involved the researcher directing the learners. At the beginning of each period, the teacher gave the assignments for that day's work. The researcher used the remainder of the period helping learners to complete these assignments. Teacher exposition and class discussions were used. Emphasis was placed on learners working individually although some unguided group/ pair discussions were allowed. The teacher did not form learner groups and the learners were not trained on the think-pair-share cooperative learning model. Table 1 shows the comparison of activities in the experimental and control groups.

Table 1: Comparison of activities in the experimental and control groups

Experimental group	**Control group**
1. The teacher presented a cooperative lesson	1. The teacher presented a lesson
2. Learners performed cooperative learning /group tasks using the Think-Pair-Share learning model	2. Learners performed individual tasks
3. Group representatives presented their findings/solution to the class	3. Learners present their findings/solutions to the class
4. Evaluation: Individual learners took assessment activities	4. Evaluation: Individual learners took assessment activities

2.6 Procedures

1. At the beginning of the study, the researcher administered a pretest on Quadratic functions for the two groups.
2. The researcher taught the experimental group about using Think-Pair-Share model(two hours' lesson). The treatment group was instructed through the Think-Pair-Share cooperative learning model for three weeks; whereas the control group received instruction through traditional methods of instruction for three weeks.
3. The experimental group using (Think-Pair-Share): the researcher begun by asking a specific higher-level question about a particular subtopic on quadratic functions, learners discussed.
   - Think: Students "think" about what they know or have learned about Quadratic functions for a given amount of time (2 - 5 minutes).
   - Pair: Each student was paired with another student. The Instructor allowed students pick their own partner. Learners shared their thinking with their partner, discussed ideas, and asked questions to their partners about their thoughts on the Quadratic functions (2-5 minutes).
   - Share: The partners shared their definitions with another pair (foursome) and had a discussion for (2–5minutes), researcher allowed each group to choose who to present their thoughts, ideas, and questions they had to the rest of the class. The researcher/teacher expanded the "share" into a whole-class discussion.
4. Three days after the completion of the treatment, the researcher administered a posttest to measure the academic performance of the two groups at the same time.

2.7 Data collection instruments and techniques

The study collected quantitative data from the participants using an Achievement test and an Attitude test. Pretest and posttest scores were collected for the achievement test while posttest scores were collected for the attitude tests in the experimental group.

2.8 Instrument reliability and validity

In order to ensure that the instruments that were used in the study were reliable and valid, the pre and posttests were peer-reviewed by the researcher and three nonparticipant teachers of mathematics as well as an independent researcher. Further, the attitude questionnaire was also reviewed by selected subject specialists. Method triangulation was also employed to the data to ensure the validity and reliability of the instruments.

2.9 Data analysis techniques

Quantitative data were analysed by computing inferential (t-tests and Mann-Whitney U tests) and descriptive statistics

(Means and Standard deviations) using the Statistical Package for the Social Sciences (SPSS) Version 20. The findings were then presented following the APA style of reporting statistical results.

III. PRESENTATION OF FINDINGS

3. Overview of the Chapter

This chapter gives a presentation of the findings of the study as per research questions. Descriptive and inferential statistics are presented according to the research questions being answered. The data were analysed using SPSS version 20.

3.1 *Comparison of post-test scores of learners in the Think-pair-share Learning Method Group and those in the Conventional Learning Method Group*

RESEARCH QUESTION 1: *"Is there a significant difference in performance in quadratic functions between the learners in the Think-pair-share Cooperative Learning Model group and those in the Conventional Learning Method group?"*

Firstly, data were checked for normality which is a requirement for running parametric analyses. Table 2 shows the results of the normality tests, which indicate that the data were normally distributed.

Table 2 Normality tests

	Group	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
POSTTEST %	Experimental	.175	19	.129	.909	19	.072
	Control	.128	23	.200*	.971	23	.718
PRETEST %	Experimental	.165	19	.184	.969	19	.760
	Control	.168	23	.091	.964	23	.544
*. This is a lower bound of the true significance.							
a. Lilliefors Significance Correction							

Since the data were normally distributed, t-tests were conducted to test the null hypothesis below, at $\alpha = 0.05$ level of significance.

$\boldsymbol{H_{0_1}}$: There is no significant difference between the performance of learners in quadratic functions in the Think-pair-share Cooperative Learning Model group and those in the Conventional Learning Method group.

The descriptive statistics (Table 3) show that in the pretest, the control group performed slightly higher (*M* = 34.57, *SD* = 17.511) than the experimental group (*M* = 31.32, *SD* = 16.902) while in the posttest, the experimental group performed higher (*M* = 71.47, *SD* = 25.650) than the control group (*M* = 51.61, *SD* = 19.965). However, independent samples t-tests show that there was no statistically significant difference in the pretest *t*(40) = -0.608, *p* = 0.547. This means that the experimental and control groups were the same before the treatment. In the posttest, there was a statistically significant difference between the performance of the experimental group and the control group *t*(40) = 2.823, *p*< 0.001. Therefore, the null hypothesis at $\alpha = 0.05$ was rejected and thereby concluding that the mean of the experimental group was higher (*M* = 71.47, *SD* = 25.650) than that of the control group (*M* = 51.61, *SD* = 19.965).

Table 3 Comparison of Experimental and Control groups in the pre-test and post-test

	Group	N	Mean score	Std. Deviation	t	p
POSTTEST score (%)	Experimental	19	71.47	25.650	2.283	.000
	Control	23	51.61	19.965		
PRETEST score (%)	Experimental	19	31.32	16.902	-.608	.547
	Control	23	34.57	17.511		

3.2 Comparison of post-test scores of male and female learners in the Cooperative Learning Method Group

Research question 2: *"Is there a significance difference between the performance of males and females in the Think-Pair-Share cooperative learning model group?"*

Normality tests showed that both pretest and posttest scores (%) were normally distributed. Table 4 shows the normality test results.

Table 4 Normality test for scores in the Cooperative Learning Group

	Gender	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Posttest score %	Female	.144	12	.200*	.954	12	.700
	Male	.198	7	.200*	.863	7	.162
Pretest score %	Female	.177	12	.200*	.953	12	.682
	Male	.169	7	.200*	.932	7	.567
*. This is a lower bound of the true significance.							
a. Lilliefors Significance Correction							

Since data were normally distributed, t-tests were run to test the null hypothesis (H_{0_2}) at 0.05 level of significance.

H_{0_2}: There is no significant difference between the performance of males and females in the Think-Pair-Share cooperative learning model group?

Results showed that in the pretest, Males (*M* = 37.143, *SD* = 18.899) performed better than females (*M* = 27.917, *SD* = 15.44). Similarly, in the posttest, males (*M* = 90.429, *SD* = 10.706) performed better than females (*M* = 60.417, *SD* = 25.536). Table 5 shows mean scores in pretest and posttest by gender.

Table 5 Comparison of Pre-test and Post-test Scores (%) in the Cooperative Learning Group by Gender

	Gender	N	Mean	Std. Deviation	t	p
Pretest score %	Female	12	27.9167	15.44173	-1.16	.263
	Male	7	37.1429	18.89822		
Posttest score %	Female	12	60.4167	25.53592	-3.569	.000
	Male	7	90.4286	10.70603		

Findings of the t-tests showed that there was no statistically significant difference between the performance of Males (*M* = 37.143, *SD* = 18.899) and Females (*M* = 27.917, *SD* = 15.44). $t(17) = -1.16$, $p = 0.263$, in the pretest.

However, there was a statistically significant difference between the performance of males and females in posttest $t(15.970) = -3.569$, $p<0.001$. Degrees of freedom were adjusted from 17 to 15.970. Therefore, the null hypothesis was rejected and conclusion that males (*M* = 90.429, *SD* = 10.706) performed better than females (*M* = 60.417, *SD* = 25.536) was drawn.

3.3 Learners' Attitudes towards Think-Pair-share CL Model and Mathematics

RESEARCH QUESTION 3: *What are the learners' attitudes towards the Think-Pair-Share cooperative learning model in the experimental group?*

Null hypothesis: Learners have neutral attitudes towards cooperative learning.

Descriptive statistics show that learners have a positive attitude towards cooperative learning and mathematics with an overall median score of 3.450. Therefore, the null hypothesis that learners have neutral attitudes towards cooperative learning and mathematics was rejected. For interpreting the mean attitude scores, the following scale was used; *0 – 0.5 = neutral, 0.6 – 1.5 = very negative, 1.6 – 2.5 = negative, 2.6 – 3.5 = positive and 3.6 – 4 = very positive.*

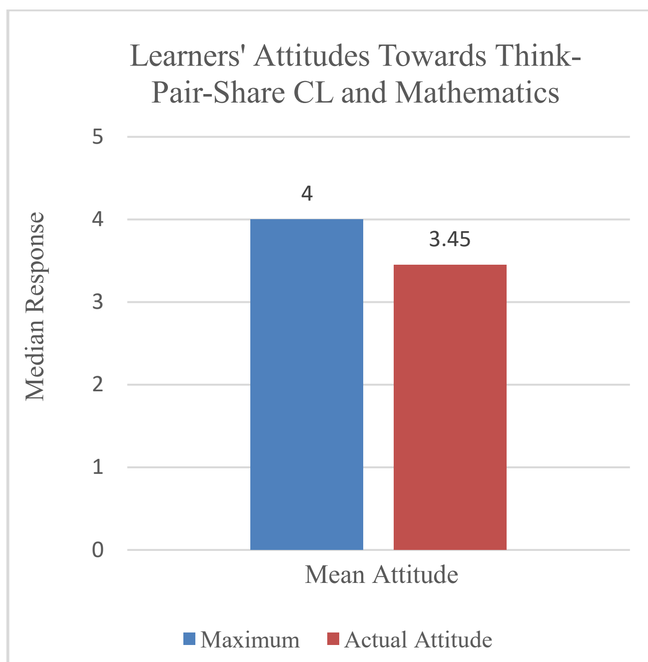

Figure 2: Learners' attitudes towards CL and Mathematics

3.4 Learners' Attitudes towards Cooperative Learning and Mathematics by Gender

Research question 4: *'Is there a significant difference between the attitudes of male and female learners towards the think-pair-share cooperative learning model?'*

Null hypothesis: There is no significant difference between the attitudes of male and female learners towards the Think-Pair-Share cooperative learning?

Figure 3 shows that the mean attitude score of males (*Mdn* = 3.65) was higher than that of females (*Mdn* = 3.40). An independent samples U test indicates a significant difference between the mean attitude of males and females (U = 77.500, p = 0.022, r = 0.512), with a large effect size.

Note: *r = effect size = $\frac{z}{\sqrt{N}}$. Cohen's classification of effectsizes is 0.1 (small effect), 0.3 (moderate effect) and 0.5 and above (large effect).*

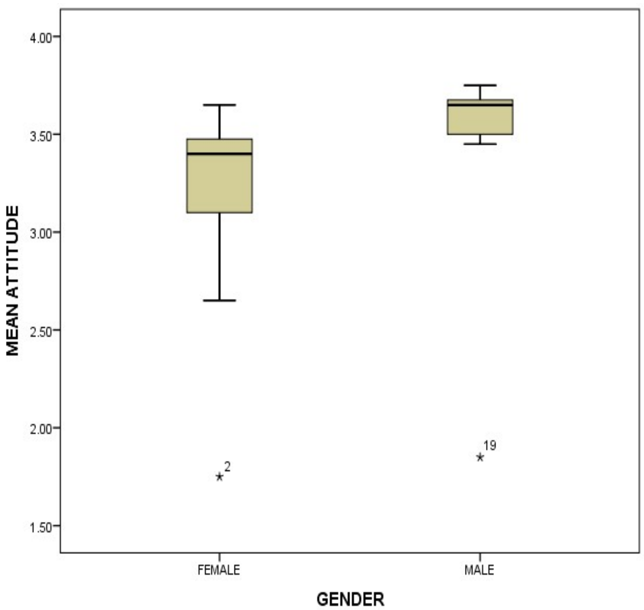

Figure 3 Mean Attitude Sores of Male and Female Learners in the Cooperative Learning Group

Table 8 Comparison of Learners' Attitudes by Gender - Hypothesis Test			
Null Hypothesis	**Test**	**Asymp. Sig. (2-tailed)**	**Decision**
The distribution of Mean Attitude is the same across categories of Gender.	Independent-Samples Mann-Whitney U Test	.022	Reject the null hypothesis.
The significance level is .05			

IV. DISCUSSION OF THE FINDINGS

4. Overview of the Chapter

This chapter presents a discussion of the findings of the study. The findings are discussed according to each of the research questions being answered.

4.1 Effect of the Think-pair-share model of Cooperative Learning Method on Performance

The study's finding that there was a statistically significant difference between the performance of the experimental group and the control group in favour of the experimental group backs many other studies (Banda & Musonda, 2018; Hossain & Tarmizi, 2013; Jebson, 2012; and Sumani & Adam, 2017). Based on this study's findings and those of others, it can be concluded that the use of the think-pair-share model can be used to improve the academic performance of learners. Therefore, teachers need to engage learners in active learning processes rather than the passive ones dominated by the lecture methods of teaching. There are many arguments that can be forwarded for the positive effect of cooperative learning models on learners' performance such as fact that the strategy provides opportunities for higher order thinking as opposed to passive listening, reinforces listening to others and gives opportunity for immediate feedback and adjustment of thought (Eslamian et al., 2012), and that group members often provide information prompts, cues, reminders, and encouragement in response to other learners' request for help or their perceived need for help (Iksan & Zakaria, 2007). Further, cooperative learning enabled students to acquire appropriate problem-solving techniques, and therefore, they were able to solve their problems better than the students in the control group. Students in the experimental group worked cooperatively to obtain shared group goals (Hossain & Tarmizi, 2013).

However, the results of the study contrast the findings by Parveen et al., (2011), who found that cooperative learning was not a superior strategy to traditional learning in the social sciences. Implications of this finding would include the need for teachers to be careful as they use cooperative learning methods. They need to ensure that a conducive environment for the use of cooperative learning is set. For example, the criteria set proposed by Johnson and Johnson (1990) need to be followed. in this case, there needs to be positive interdependence, promotive interaction, individual accountability, interpersonal skills, and group processing.

However, the conventional learning approach does not allow deep learning by the learners due to the passive nature of the learning process. In the conventional groups, learners lacked support from their peers and therefore did not learn from the social learning environment provided in the classroom. Learners need to talk to one another about their learning, this is usually missing inconventional teaching approach. In fact, knowledge is not always passively received; it is actually better received through active learning which assists in developing investigative skills that are vital in the modern world (Lehong & Jeridah, 2016). Unfortunately, this too is lacking in the conventional learning methods, thereby resulting in lower learning compared to learning approaches where learners are actively engaged in the learning process.

4.2 Effect of Think-pair-share Cooperative Learning Model on Learners' Attitudes towards Mathematics

The study's finding that learners have a positive attitude towards Think-Pair-Share model of cooperative learning and mathematics is in support of the findings by other researchers (Banda & Musonda, 2018; Akhtar, Perveen, Rashid, & Satti, 2012; Gamit, Antolin, and Gabriel, 2017). Generally, the students agreed that they were committed to the success of the group and took responsibility for the success of each group member. The strategy enhanced their learning of quadratic functions, and allowed the learners sufficient time to complete the task. Cooperative learning enhanced their learning and socialization and gave them opportunity to interestingly complete their tasks. Learners learnt better than they would in individual learning and they felt satisfied in cooperative learning. Further, they also agreed that the Think-Pair-Share cooperative learning increased their interest in mathematics and that they need others to learn. The learners' positive attitudes towards mathematics and cooperative learning could be attributed to factors such as increased engagement and motivation to learn.

4.3 Effect of Think-pair-share Cooperative Learning Model On Learners' Attitudes Towards Mathematics by gender

The study's finding that a significant difference exists between male and female learners existed has implications for teaching and learning. The results suggest that males benefited more than the girls who were both subjected to cooperative learning. For teachers, they need to engage the learners equally if they are to benefit from lessons. The findings may mean that the boys benefited more from cooperative learning than their female counterparts. One of the reasons for that is because the boys seemed to dominate the discussions while the girls were more of the passive ones. As such they could not benefit as much as the boys who were actively involved in the learning process. According to the constructivist view of learning, learners construct learning by actively interrogating the subject matter. Through the think-pair-share approach of cooperative learning, learning who were able to engage in the thinking process about the content of the lessons, learnt more than those who did not engage as much.

V. CONCLUSION AND RECOMMENDATIONS

5. Overview of the Chapter

This chapter presents the conclusions made based on the study as well as the recommendations formulated.

5.1 Conclusion

This study was aimed at investigating the impact of the Think-Pair-Share cooperative learning model on grade 12 learners' understanding of quadratic functions. The study also determined learners' attitudes towards mathematics as well as cooperative learning as a learning approach.

The study revealed that cooperative learning has the potential to improve the performance of learners in quadratic functions if used effectively as it was shown in this study. The study also established that cooperative learning improves the learners' attitudes towards mathematics regardless of their gender. These findings have implications for the understanding of issues associated with the low pass rate in mathematics and how the performance can be turned around. Reasons advanced for the improved performance and attitudes include increased opportunities for higher order thinking, opportunities for learners to listen to others' ideas, immediate feedback given, adjustment of thought, ability of group members to provide information prompts, cues, reminders and encouragement in response to other learners' acquisition of appropriate problem solving techniques.

5.2 Recommendations

From the foregoing, the following recommendations are proposed;

1. Teachers of mathematics should incorporate the think-pair-share model of cooperative learning in their teaching process as it has the potential not only to increase learners' motivation but also their performance in mathematics.
2. The teachers should further reflect on how to bridge the observed gender gap in order to provide equitable quality education to all.
3. Policymakers should enhance the conduct of in-service programs (continuous professional development) programs to educate teachers on good practices with regard to cooperative learning.
4. More research to be conducted in different parts of the country and grade levels to ascertain the impact of cooperative learning.
5. Teachers to engage in action research based on effective practices incorporating the think-pair-share model of cooperative learning ideology.

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