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EFFICACY OF TRADITIONAL AND PROBLEM-SOLVING METHODS ON TEACHER-STUDENT INTERACTIONS AND STUDENTS PERFORMANCE IN ARITHMETIC AND ALGEBRA IN ISSA DISTRICT OF UPPER WEST REGION, GHANA

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Abstract: **The mathematics content has been a growing and a complex entity and this has created a public uproar in the mathematics space on the kind of strategies teachers should employ in classroom delivery to enhance teacher-student classroom interactions. This paper is designed to investigate the traditional method and problem-solving method of teaching mathematics to determine the most effective method that promote teacher-student interactions in mathematics lessons and to determine whether the method that enhances effective teacher-student interactions yields better performance in mathematics. The study employs quasi-experimental research design where intact classes were used for data collection. Observation and achievement test were also used as instruments for the collection of data from 133 primary six (6) pupils. A single teacher was tasked to facilitate the classroom activities. The data collected was analyzed using frequency counts, percentages and independent sample t-test. The observation results indicated that both methods had an appreciable level of teacher-student interactions, however the problem-solving method of teaching mathematics was better placed in terms of teacher-student interactions compared with the traditional method of teaching mathematics. It was also shown that the students in the Problem-Solving Method group performed better than the students in the Traditional Method group. The researcher recommended that teachers should employ problem solving method to better enhance teacher-student interactions and subsequently the performance of pupil in mathematics.**

Keywords: **Problem Solving Method, Teacher- Student Interactions, Traditional Method.**

1. INTRODUCTION

Some authorities appreciated mathematics by giving their definition as a system of tools kit by which people can select and apply to build up better knowledge and status in the society in which they live (Ahmad, Shakir, & Raza, 2019). Mathematics, notwithstanding its basic function, is to increase one's reasoning ability, plays an important role in the scientific and socio-economic development of a nation, the overall personal and intellectual development of every individual in a society. Dookurong et al (2020) justifies that mathematics is life without which a man cannot live. Again, countries that have seen mathematics as a pivot to development have their policy directions focused on great effort of emphasis in the study of science and mathematics (Dookurong and Yaw, 2020). Governments all over the world make conscientious efforts to ease the learning of mathematics and to popularize its study (Isaiah and Yaw, 2020). In Ghana and the world over, mathematics is a compulsory subject of study at all stages of pre-university education. Every student is required to pass mathematics before proceeding to the next educational level. At the primary schools in Ghana, the mathematics curriculum aims at enabling students to use mathematics in their daily life activities and to also recognize situations that require mathematical problem-solving strategies and apply mathematics to resolve them (Ministry of Education, 2010). However, the learning of mathematics has been a challenge for many students at all levels.

2. PROBLEM SOLVING METHOD OF TEACHING

Problem solving method of teaching employs various strategies or techniques to solve a mathematical task that does not have a routine path to its solution. The primary aim of the problem-solving method is to objectively focus on students thinking processes and these thinking processes may be enhanced via teacher-student interactions. A teacher who applies problem solving methods of teaching in his class, consciously or unconsciously is nurturing the following in the learner:

- Dynamic thinker,
- perceptual variability thinker,
- mathematical variability thinker, and
- constructive thinker.

These constructs, if developed, can be of assistance for students to have a complete formation of transferable core skills, critical thinking and imbibe problem solving strategies. The study adopted Polya's Problem Solving Model to address the issue of teacher-student interaction because the model operational definition is in line with developing the constructs under consideration. This model consists of four stages namely: Understanding the problem; Devising a plan; Carrying out the plan; and looking back. According to Polya (1957), the problem solver must comprehend the problem first, then move ahead to devise a workable plan, proceed to carry out the plan and finally look back, which indicates checking the solution and solution process. In applying the problem-solving method to solve mathematical problems, the first step is to read and understand the mathematics problem. Understanding the mathematics problem first implies getting acquainted with the problem by identifying the unknown, the known and the relationship between them as well as knowing students' entry behaviour for the solving of the problem. Polya's model is actually a form of effective classroom interaction because it requires students to apply negotiations skillfully in the classroom with the teacher to develop deeper understanding of the task being posed. In understanding the problem stage, Polya's model asks the following questions:

- Do you understand all the words used in stating the problem?
- What are you asked to find or show?
- Can you restate the problem in your own words?
- Can you think of a picture or a diagram that might help you understand the problem?
- Is there enough information to enable you to find a solution?

The second step is devising a plan for solving the problem. The students by negotiation determine the connection between the data and the unknown and plan for the solution. The model demands that the students ask questions such as;

- Have we seen the same type of problem in a slightly different form?
- Do we try to think of a familiar problem having the same or a similar unknown?

- Can the problem be restated differently?
- Did we use all the data?

Response to these questions will enable the students to arrive at workable solution strategies. Students may explore with the information before they think of a possible strategy that might yield the solution. The exploration will help the students to comprehend the problem better and also become aware of unused information after the first reading. The students may look for a pattern, make a diagram, write an equation, work backwards, make a table, make a model, use indirect reasoning, and solve a simple or similar problem as possible strategies.

The third step is carrying out the plan. Students are required to choose a specific plan and follow a prescribed procedure when they are implementing the plan. The students:

- Solve the problem using the chosen plan;
- Double check each step;
- Try a different plan if the chosen plan is not working after a few attempts;
- Allow for mistakes (remember the plan may need some revision).
- Check your answer.

Looking back is the final stage of the proposed theorem. At this point, the students have arrived at a solution but they have to check to be sure they are correct in the problem-solving process. Much can be gained by taking time to reflect and look back at what has been done, what worked and what has not worked. In using the problem-solving method, the following questions may be used as checks at the looking back stage:

- Can we check the result?
- Can we check the argument?
- Does our answer make sense?
- Did we answer all parts of the question?
- What methods worked? What methods failed? What did you learn from completing this problem?
- Could we have solved the problem in another way?
- Is there an easier way to solve this problem?
- If we encounter a similar problem in the future, how can we better solve it?

For instant, problem solving interaction strategies can be demonstrated with the example below. In calculating the mean of 8 numbers, a girl mistakenly used 17 instead of 25 as one of the numbers and obtained 20 as the mean. Find the correct mean. This problem is used to demonstrate how the model can be applied.

Step 1: Understand the problem:

The student reads the question carefully several times. Since the problem is looking for correct mean, the problem solver will extract the known and unknown data from the problem.

Step 2: Devise a plan (translate).

The student translates the word problem into symbolic form such as:

Sum of the numbers when 17 was recorded as one of the numbers : $8 \times 20 = 160$

The difference between the correct and incorrect numbers : $25 - 17 = 8$

Step 3: Carry out the plan (solve).

The student solves it using the addition and division facts such as:

The correct sum $= 160 + 8 = 168$

The correct mean$= \frac{168}{8} = 21$

Step 4: Look back (check and interpret).

The student checks the results and interprets the solution as: In calculating the mean of 8 numbers, a girl mistakenly used 17 instead of 25 as one of the numbers and obtained 20 as the mean then the correct mean is 21.

Final Answer: The correct mean is 21. But to many mathematics literates, learning mathematics is solving mathematics problems via student teacher classroom problem solving interactions.

3. TRADITIONAL METHOD OF TEACHING

The framework of discussion in most teaching and learning process depicted traditional classrooms. Thus, one-sided interaction from the teacher to the students is the norm of teaching and learning process today. Akbar and Margana (2019) highlighted that data gathered from observations from students in more than one thousand traditional classrooms endorse the famous picture of a teacher standing before a class adding knowledge to a group of students. Atteh, Andam, Amoako, Obeng–Denteh and Wiafe (2017) found that in traditional classroom setting, teachers speak 90% of the schedule time in teaching and learning. Battey and Leyva (2013) observed that students in the traditional classrooms are meant to take notes, and answer questions with short or little interaction with colleagues.

Brijlall (2015) and Brue (2017) indicated that teachers are unrest and spent a lot of energy developing lecture notes and tutorials for the purpose of giving education to their learners, they become very fatigue by studying different texts and synthesize the information, select the most relevant ideas and coordinate them in a chronologically manner and then bear the data to learners who sit down passively often not thinking of anything only what the teacher is talking about, the teacher is the one reading, writing, thinking, speaking, and therefore, the one who is learning. Instead of students who would have been doing all that for themselves to construct their own knowledge it is the teacher. With all these efforts made by teachers, students still perform poorly whenever they take mathematics examinations (Robert, 2017). The researcher argues that apart from the above unproductive protocols still teachers upheld to giving assignment every day, always giving activities and lecture all day to students. The teaching and learning materials are white board, black board, marker and chalk or probable stating things that are not in the classroom.

4. TEACHER-STUDENTS' INTERACTIONS

Teacher-student interactions give a singular point to improve the social learning environment of schools, classroom activities, indirectly consolidate gender equity and inclusiveness since most students would participate actively in the teaching and learning processes. Several studies on teacher student interactions have been consistently connected to students putting relevant questions to teachers or peers to help them resolve issues at hand (Ginting, 2017; Huster, Wallace and Nixon, 2019; Isaiah, Yaw and Sulemana, 2020) and this is correlated with high achievement, positive conducts, engagement in school and classroom. Therefore, good attitude is a primary determinant of good teacher students' relationships and interactions (Isaiah, Yaw and Sulemana, 2020) and must be re-enforced to ensure extreme teacher student interaction.

In the early stage in school, teachers need to provide support and guidance to establish the fundamentals for teacher-students' interactions in classroom. One way a teacher can build the basis for teacher students' interactions in classroom is classroom organization and engagement. It is found that, high quality classroom organizations have been connected to engagement (Isaiah, Yaw and Sulemana, 2020). A sense was made in literature that teachers who asked students challenging and thinking questions in addition to stimulated students to express the evidence behind their remarks in classroom activities improved the quality of the classroom discourse and engagement (Carson, 2007; Daulay, 2019; Fahruchin, Mardiyana and Pramudiya, 2018). Teacher students' interaction establishes clear routines activities that can increase the self-regulated behavior (initiation) of students throughout the teaching and learning process and this has a higher level of productivity and a lot of opportunities created by teachers who can stimulate teacher students' interaction in teaching and learning but these advantages are hindered by challenges (Carson, 2007; Daulay, 2019; Fahruchin, Mardiyana and Pramudiya, 2018). In the advent of today's social media students have little interaction in many of today's mathematics classrooms from kindergartens to universities level in Ghana. One major way for students to enhance these crucial responsibilities for their own learning is to be the actors (answerers) such as readers, writers, speakers, listeners, and thinkers in the classroom through active engagement in teacher students' interactions (Fahruchin, Mardiyana and Pramudiya, 2018). For the purpose of this study, teacher-student interactions are defined as meaningful negotiation among learners and teacher in the classroom

to improve the probability of the process of understanding in teaching and learning. Learning can be maximized extremely when students have confident to communicate, cooperate, interact with, analyze, synthesis, collaborate, discuss and share ideas among themselves (Jacob, Martin, Ambrose and Philipp, 2014). Teacher students' interaction can enhance and better improve these in the Ghanaian classrooms setting.

It is grounded that students' social interaction influences their learning achievement in Mathematics subject and also enhance their confident and ability to do mathematics. They would take the responsibility of learning by applying problem solving via the study of technology, science, mathematics, and ultimately a good character formation. These relieves were corroborated with the findings of (Khun-Inkeeree, Omar-Fauzee and Othman ,2017; Apriliyanto, Saputro and Riyadi, 2017; Furner, 2017; Foster,2015) who found that self- confidence improves students interacting with each other in the group, each member has a role to play in the group to enhance their social interaction and therefore enhance achievement.

Teachers' verbal questioning within a mathematics classroom and examining the role of questions in the classroom can go extremely to enhance effectiveness in teaching of mathematics. Exploring the effect of wait-time and report on the effects from teacher questioning on gender and social class also improve students' performance. It was argued in literature that teacher verbal questioning and its role are an important part of a student-inquiry classroom and learning. These bring about students' engagement in mathematical thinking, confirmation, justification, and clarification of questions. Questions in school setting are perceived as some sort of diagnostic process, through which learners supposedly learn and this follows up to adult-child interactions. Many classroom interactions are some variants on guess what is in my mind. These grounds are in line with several studies such as (Mason, 2010; Shahrill, 2013; McCarthy, sintholee, McCarthy, and Gyan, 2016; Wong, 2012; Dong, Seah and Clarke, 2018; Dahain, Laintel and Paint, 2019) who found that, by applying various reform-based questioning strategies, students were given adequate opportunities to present and share their mathematical thinking and ideas. They stated again that the nature of the pedagogical tension has shifted from imbalance of time allocation for classroom discussion and lecturing to imbalance of opportunities for guided classroom discussion and elaborated classroom discussion. They also found that if teachers are guided through analysis of questions they ask and the responses they get from students during mathematical discourse, it will enable them to recognize both effective and ineffective questioning strategies in their mathematical classroom discourse and may assist them to be well aware of their questioning practices by reflecting on the questioning strategies they use in their own mathematical classroom discourse.

Many years since, Goodman (1986) cited in Kushwaha (2014) found that teachers mess up at the point of lesson development, thus deficient in clarification of concepts. He suggested that reading, writing, listening and speaking on concepts should be kept simultaneously, instead of treating each one separately (Kushwaha,2014). He further advised that these activities above should be incorporated into whatever students are doing throughout the learning process. As reading, writing, and teacher student interaction are inseparable of everyday life in the actual classroom world**,** it is not wise for classrooms to comprise teacher students' interaction-free zones whereby the teacher speaks while students listen. Nuraini (2019) categories reading and writing should be summed, while listening, interacting and using language to think about a concept and act on it in the classroom world must be put on other side.

Nuraini (2019) stated that the lecture method used in class reduced teacher students' interactions. He added that teachers in the past who worked hard to keep children quiet in class did not know how relevantly teacher students' interaction and collaboration are in teaching and learning of mathematics, they needed to integrate teacher students' interaction into their classrooms learning. Teacher students' interaction provides opportunities to students to think critically, interact with, analyze, classify, synthesis, plan, extract information, compare solutions, and argue among themselves base on their individual differences and different prior knowledge. The researcher therefore indicates that when teachers are applying this in their classroom it will reduce many teachers spending better part of their time to get students participating actively in class, thus exposing their difficulty. The matter is to simple pursuing students to expose their difficulties in the subject matter under treatment and the above digestions are characterized by teacher students' interactions which one can employ to better win the attention of students to perform well in mathematics class.

Most classroom teaching and learning process are characterized by note taking and making (Roditi and Haspekian, 2017; Sun and Wu, 2016). They suggested that teacher students' interactions in school environments are to organize, guide, interact with which could one way or the other change the classroom atmosphere and students' conduct to be able to prepare their own notes; teacher student interaction is one of the many important determinants of classroom engagement and discipline, which maybe associated to teachers' positive attitude in the classroom (Petek, (2012). The most usual teacher

students' interactions found in literature are: teacher questions student; answer-teacher evaluation; teacher emotional support; teacher organizational and instructional support (Oladide, Esther and Levi, 2019). These models indicated a traditional style of teachers' role in classroom delivery and control. The quality of teacher students' interactions is a critical factor for whether or not trouble with classroom management may go on, and for that matter very crucial to problem solving (Suryatics, 2015; Wang, 2017).

Aprillyanto, Saputro, Riyadi (2017) suggested that a teacher can increase teacher students' interactions by employing approval behaviors. Approval behaviors in the classroom are: reinforcing students' appropriate behaviors, praising a students' appropriate behavior, expressing satisfaction about students' work, behavior, or performance. Disapproval behaviors which must be discouraged in classroom are: reprimanding and criticizing with a verbal or nonverbal response to an inappropriate behavior. Apart from positive teacher students' interactions, negative teacher student interactions in school classroom contains teachers' behavior of punishing and criticizing students, which can influence student's social, emotional engagement (Razieh and Nabavi, 2012) and therefore affect their mathematical learning. For the purpose of this study, many studies success in the area of student teacher classroom interaction but not investigating the rate of teacher students' interactions between Traditional method and problem-solving method in the classroom deliveries which one increases classroom interactions, hence, it is in this vein that the researcher seeks to investigate traditional and problem-solving method of teaching which one increases classroom interactions.

5. STATEMENT OF THE PROBLEM

Due to the dynamic nature of the society, mathematics content has been a growing and a complex entity to understand and this has created in mathematics space a public uproar on what kind of strategies teachers can employ in their classroom delivery. The better the teacher - students' interactions during mathematics teaching and learning the greater the possibility of performing well in mathematics (Oladide et al, 2019). Mathematics is thought of as a vibrant and robust pillar to the development of nation's economics. The methodology that can assist to improve upon the learning of mathematics in order to strengthen the economics of countries is critical. Based on this need, this paper is designed to investigate whether the traditional or problem-solving method of teaching enhances teacher-students' interaction in the classroom.

6. RESEARCH QUESTION AND HYPOTHESIS

6.1Research Question

Which method of teaching mathematics enhances teacher-student interactions in the classroom?

6.2 Hypothesis

There is no significant difference in the mean scores of the group of students taught using Polya Problem Solving Approach (PPSA) and students taught using Traditional Method (TM).

7. METHOD

Before the researcher embarked on data collection, certain mechanisms were put in place in order to avoid issues of data not being quality to execute the task raised in the study. The researcher takes conscientious to establish cordially relationship with the teacher that would be engaging students in the classroom. Twenty lesson notes were prepared: Ten for the Traditional methods of teaching and the other ten problem solving methods of teaching. Without any training, the researcher collects data on the traditional method of teaching to avoid influence that the training might have affected. The researcher then equips details training to the teacher and how he would present these problem-solving lessons. These twenty lesson plans were learned and practised by the teacher for two weeks. The teacher was trained to follow strictly by the protocols of the polya problem solving approach lesson plans.

The participants of the study were taken from two schools; sixty-one (61) from Issa L/A B6 and seventy-two (72) from Nadowli L/A B6, in the Issa District of Upper West Region, Ghana. The researcher employed a quasi-experimental designed where two groups were constituted: the experimental and control groups. with B6 pupils and sample 133 of which qualitative data were collected from 61 B6 pupils with direct participant observation which indicated that the researcher was non-participant but still be showed at the setting in which student teacher interactions happens (Creswell, 2014).

The researcher used observational protocols and achievement test to gather data from each method. There were three portions of data recorded, two from the observation protocols and one from achievement test: Part one records data of the participants from traditional method of teaching, part two records Polya problem solving method in which both of them depended on the teacher students interaction self-Evaluation Tally Sheet Instrument developed by the researcher and part three records data from the achievement test, one main component was used: the rate of teacher students interactions' strategies. The teacher students' interaction self-Evaluation Tally Sheet Instrument was used in the observation strategies to establish the various protocols teachers used in their lessons. The teacher students' interaction self-Evaluation Tally Sheet Instrument consisted of eight strategies. The strategies are pertained to the pedagogical purposes in the classroom and the attitude that the teacher might have employed to accomplish them. The classroom interaction strategies are: teacher clarifications, teacher directs or orders, students questioning, students answering, teacher encourages, students' initiations, teacher accepts and students' confidence.

The two methodologies were observed ten (10) times each. After the last lesson observation, the researcher re-examined lessons observed notes. A total of twenty lessons were observed of which each lesson exhausted 35 minutes. The teacher student interaction self-Evaluation Tally Sheet Instrument collected data were qualitative data and analyzed using frequency counts and percentages. The level of analysis aimed at identify the frequency of interactions and strategies used base on the strategies in the teacher student interaction self-Evaluation Tally Sheet Instrument.

The researcher again designed the achievement test from the B6 curriculum and teacher's pack. The content was mainly arithmetic and algebra. Two parallel tests items were set and one was used to collect the baseline data to ensure that subjects have the same entry behaviours and the other one was used to collect post test data. However, the pupils' demographics data were not collected because the researcher main purpose was to investigate teacher students' interactions in the classroom. The collected data was analyzed using independent sample t-test.

8. RESULTS/DISCUSSIONS

Table 1: Results of Rate of Teacher - Student Interactions in the Classroom

Construct	**Traditional**	**Method**	**Polya problem**	**Solving principles**	**Gain Difference N (%)**	**Total no of students**
	N (%)	N (%)	N (%)	N' (%)	N (%)	N +N'
1.Teacher clarifies, building and developing ideas suggested by students	19(14.8)	42(68.9)	42(68.9)	19(31.1)	33(54.1)	61
2.Teacher directs or orders with which students expected to comply	17(27.9)	44(72.1)	47(77.0)	14(23.0)	30(49.1)	61
3.Students questioning skills	15(24.6)	46(75.4)	45(73.8)	16(26.2)	30(49.2)	61
4. Students answering skills	20(32.8)	41(67.2)	50(82.0)	11(18.0)	30(49.2)	61
5.Teacher encourages students' actions or behaviours and reinforcements	16(26.2)	45(73.8)	48(78.7)	21(23.3)	32(52.5)	61
6. Students talk by initiation	21(34.4)	40(65.6)	49(80.3)	12(19.7)	28(45.9)	61
7. Teacher attitude toward students and response appropriately	20(32.8)	41(67.2)	39(64.0)	22(36.0)	19(31.2)	61
8. Students' confidence in talking	12(19.7)	49(80.3)	50(82.0)	11(18.0)	38(62.3)	61
Average	16.3(26.7)	44.8(73.4)	46.3(75.8)	14.8(24.2)	30(49.2)	

The results in Table 1 indicated that problem solving methods of teaching increases teacher students' interactions in the classroom. These are showed in the gained difference between the two approaches as n (%) represents the rate of teacher students' interactions difference: teacher clarifies 33(54.1), teacher directs or orders 30(49.1), students questioning 30(49.2), students answering 30(49.2), teacher encourages 32(52.5), students' initiations 28(45.9), Teacher's acceptant 19(31.2) and students' confidence 38(62.3). The average rate of teacher students' interactions difference is 30(49.2) which show a remarkable improvement of the problem-solving interaction in the classroom. These findings are consistent with several studies (Carson, 2007; Suryatics, 2015; Sun and Wu, 2016; Prillyanto, Saputro and Riyadi, 2017; Wang, 2017; Roditi and

Haspekian, 2017; Fahruchin, Mardiyana and Pramudiya, 2018; Daulay, 2019; Ahmad, Shakir and Raza, 2019; Oladide, Esther and Levi, 2019; Akbar and Margana, 2019; Isaiah, Yaw and Sulemana, 2020; Isaiah and Yaw, 2020).

Table 2: The statistical distribution of the mean and standard deviations

Construct	TM Mean	TM Standard Deviation	PS Mean	PS Standard Deviation
1. Teacher clarifies, building and developing ideas suggested by students	2.3	3.3	3.8	1.3
2. Teacher directs or orders with which students expected to comply	1.6	2.1	4.3	1.9
3.Students questioning skills	3.7	3.0	5.0	0.8
4.Students answering skills	2.0	3.6	4.5	1.1
5. Teacher encourages students' actions or behaviors and reinforcements	3.1	2.7	4.2	1.7
6. Students talk by initiation	1.2	2.4	3.9	1.5
7. Teacher attitude toward students and response appropriately	1.8	2.3	5.1	0.6
8. Students' confidence in talking	2.9	3.9	4.2	1.0

TM = Traditional Method PS= Problem Solving

From table 2, it can be deduced that, the traditional method of teaching, the rates of teacher students' interactions were not highly effective and this depicted from the results of the various means and their standard deviations. It is evidence from the results that the various means are lesser than their standard deviations. This indicated that the rates of teacher students' interactions were widely spread and suggested ineffectiveness of the rate of teacher students' interaction. However, the problem-solving method teaching, the various means were greater than their standard deviations and this suggested that the rates of teacher students' interaction were effective and students were contributing a lot to the lessons

Hypothesis: *There is no significant difference in the mean achievement scores of students taught mathematics using Polya Problem Solving Approach (PPSA) and those taught using traditional method (TM).*

The researcher determined the effect of PPSA on B6 students' achievement in solving problems involving arithmetic and algebra by comparing the scores of both groups in the pre and post tests using independent sample *t*-test. The results of the analysis are summarized in the tables 3 and 4 below.

Table 3: Independent Samples *t*-test for Treatment and Control Groups (Pre-intervention)

Tests	**Groups**	**N**	**Mean**	**Standard Deviation**	**t-value**	**p-value**
Pre-intervention	Treatment Group	61	2.52	0.971	0.932	0.355
	Control Group	72	2.55	0.955		

Table 4: Independent Samples *t*-test for Treatment and Control Groups (Post-intervention)

Tests	**Groups**	**N**	**Mean**	**Standard Deviation**	**t-value**	**p-value**
Post-intervention	Treatment Group	61	7.82	1.001	13.255	0.000
	Control Group	72	4.54	1.022		

Before the intervention, an independent samples t-test was conducted to compare the pre-test mean scores for the two samples to ensure that the samples have the same entry behaviors, baseline, strength and achievement. The pre-test results indicated that mean scores for treatment group ($M = 2.52, SD = .971$) were not significantly higher than mean scores for control group ($M = 2.55, SD = 0.955$). The independent samples t-test also found it to be not significant as $t(70) =$

0.932,$p = .355$. The results of the independent samples *t*-test on the participants' scores in the pre-test, are presented in Table 3. It shows the pre-test mean scores of the treatment and control groups. The results indicate that the mean score for treatment group was 2.52 with a standard deviation of 0.971 and that of the control group was 2.55 with a standard deviation of 0.955. The results indicate that the difference between the achievement mean scores for the treatment and control groups were not significantly (p = 0.355> 0.05). This, therefore, means that the treatment and the control groups were at the same entry behaviours, level, strength and achievement at the start of study.

The same independent samples *t*-test inferential analysis was used to analyze the post-test data collected. The post-test results indicated that the mean scores for treatment group ($M = 7.82, SD = 1.001$) were significantly higher than scores for control group ($M = 4.54, SD = 1.022$) and independent samples t-test found the post-test results of the treatment group to be significant $t(70) = 13.255, p > .000$. The results are presented in Table 4 above.

Tables 3 and 4 shows the results of the independent samles t-test indicating that the difference between the achievement mean score for treatment and control groups was significant (p = 0.000 < 0.05) which indicate that there has been a remarkable improvement in the achievement of students in the treatment group. The result also affirms that there is significant difference between the mean achievement scores of students taught using PPSA and those taught using TM. Thus, the hypothesis, that there was no significant difference, was rejected. That is Participatory problem-solving learning group achieved higher in the post-test scores than the Traditional problem-solving group of students.

9. CONCLUSION

The researcher concluded that Polya problem solving approach improves the rate of teacher students' interactions more than the traditional methods. The teacher's job in the classroom was less where students were actively participating, interacting, sharing of ideas, analyzing issues and engaging when applying the problem-solving method of teaching and vice visa.

10. RECOMMENDATION

Base on the findings, the researcher recommends that mathematics teachers should apply Polya problem solving approach during their lessons and students should apply problem during learning so that to increase the rate of students' interactions, hence improve students' achievement in mathematics. That future research should be conducted in the Junior High School.

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